‘Heliophysics in Europe and 1st European Heliophysics Community meeting'

19-21 November 2024

Please review the code of conduct

Please look at main page online for updates –

https://www.cosmos.esa.int/web/esa-heliophysics/heliophysics-in-europe-2024

Zulip and details for questionnaires

ESA activities in the area of Heliophysics

ESA Heliophysics

Heliophysics-

- *Covers the science of understanding the Sun and its interaction with the Earth and the solar system including planets and small bodies.*
- *Encompasses Solar System plasma physics and space weather.*
- *Has a large and active international community, with significant expertise and heritage in Europe*

ESA and Heliophysics

Several directorates in ESA carry out activities in the area of Heliophysics: Directorate of Science (D/SCI), Directorate of Earth Observations (D/EOP), Directorate of Human and Robotic Exploration (D/HRE), Directorate of Technology, Engineering and Quality (D/TEC) and Directorate of Operations (D/OPS)

To improve coordination of these activities internally within ESA, the ESA Heliophysics Working Group was formed.

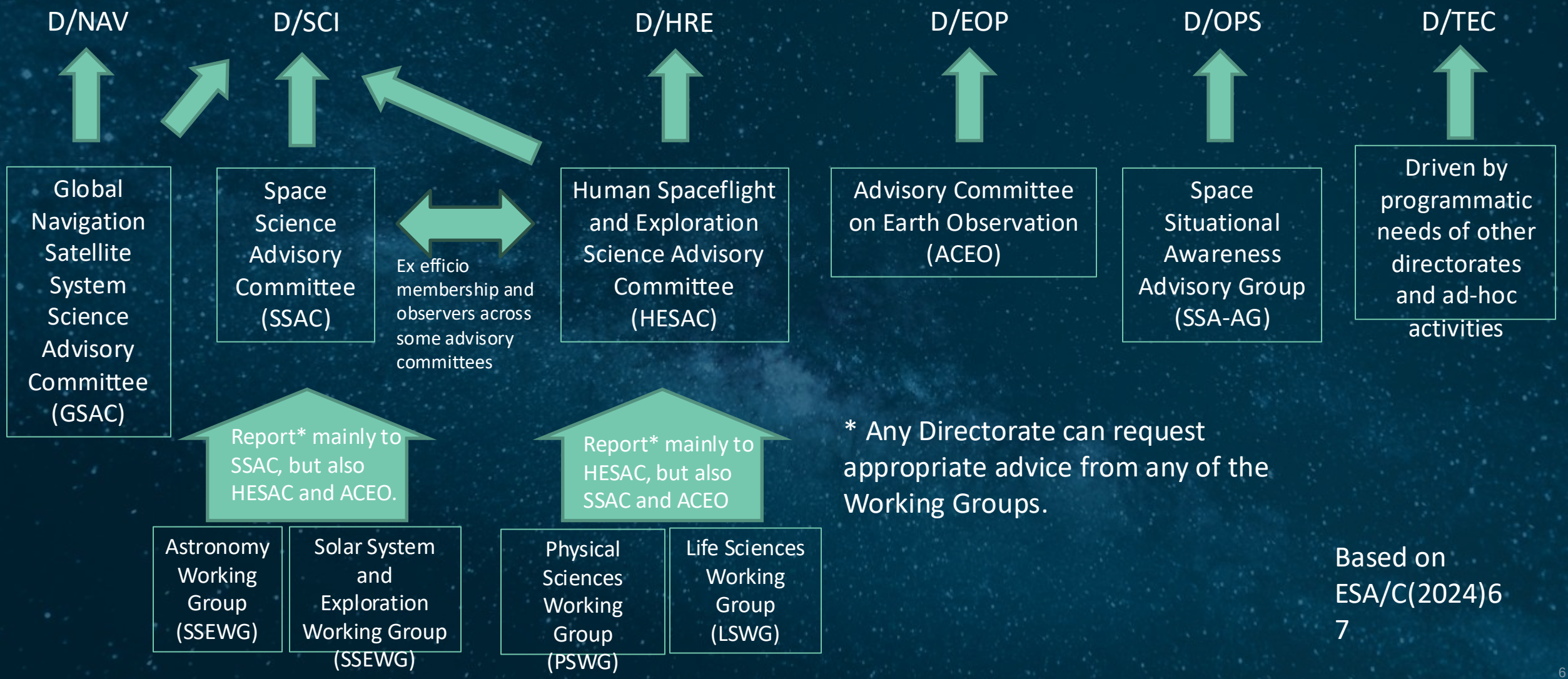
The Heliophysics Working Group (HWG) is appointed by the Directors of SCI, EOP, HRE, OPS and TEC to provide internal guidance on all scientific aspects in the area of Heliophysics, under the Chairship of the D/SCI representative of the WG.

D/EOP	Anja Strømme
D/HRE	Sebastien Vincent-Bonnieu
D/OPS	Juha-Pekka Luntama
D/SCI (chair)	Matt Taylor
D/TEC	Piers Jiggens

ESA Heliophysics Working Group:

- Provide a scientifically unified view in the area of Heliophysics, in light of the plans of the involved Directorates;
- Act as focus for discussion inside ESA of the scientific interests of the Heliophysics community, including the European ground-based community and data archiving activities;
- Assess potential synergies and provide inputs and recommendations as relevant to the involved Directorates.
- Set up dedicated internal workshops to build on existing synergies + dedicated community workshops to build on these internal synergies and receive inputs from the scientific community that cuts across ESA programmes.
- The HWG will identify any potential science synergies and where relevant, specific information will be consolidated into recommendations to be issued to the ESA Directors and relevant coordination entities. The relevant science advisory groups will be kept informed regularly of the HWG activities.

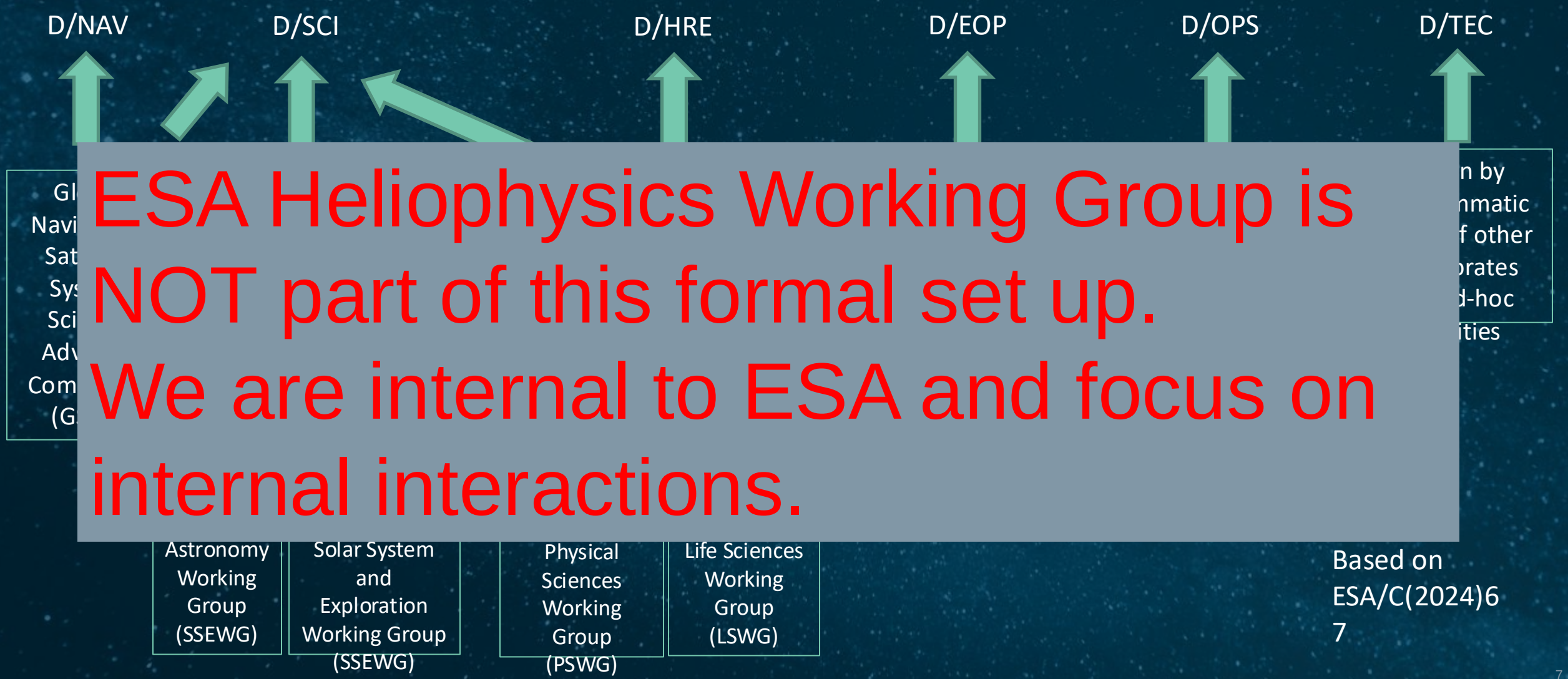
ESA Science Advisory Committees and Working Groups



* Any Directorate can request appropriate advice from any of the Working Groups.

Based on ESA/C(2024)67

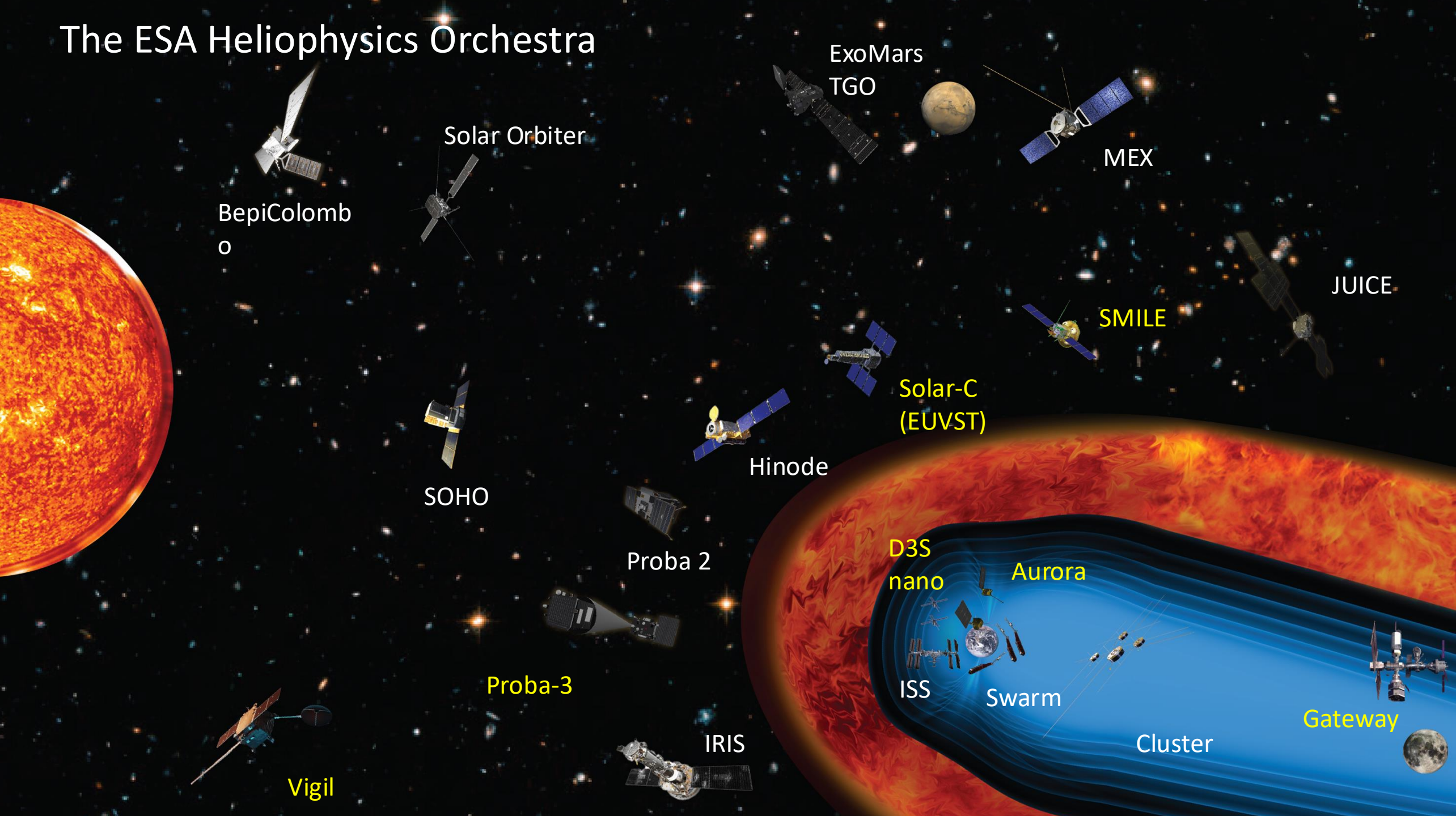
ESA Science Advisory Committees and Working Groups



ESA Heliophysics Working Group is NOT part of this formal set up.

We are internal to ESA and focus on internal interactions.

Based on ESA/C(2024)67


The ESA Heliophysics Orchestra
ExoMars
TGO
MEX
Solar Orbiter
BepiColombo
JUICE
SMILE
Solar-C
(EUVST)
Hinode
SOHO
Proba 2
D3S
nano
Aurora
ISS
Swarm
Cluster
Gateway
Proba-3
IRIS
Vigil

ESA Heliophysics

UPDATES FROM ESA Directorates

ESA Heliophysics

Update since last meeting - from Directorate of Operations (D/OPS)

Space Safety Programme Space Weather Activities

Juha-Pekka Luntama, Alexi Glover, Melanie Heil, Stefan Kraft, Jorge Amaya, Mehdi Scoubeau
Space Weather Office
European Space Agency

Space Weather Activities in S2P - Overview

Space Safety Programme works to **improve our Space Weather forecasting capabilities** and **to transition mature service elements into an operational framework**:

a. An **enhanced space weather monitoring system** providing data for more accurate Space Weather now- and forecasts as well as improved monitoring of space weather impacts.

b. Services tailored to European user needs providing timely, accurate and actionable information for all user domains, with a clear maintenance and enhancement plan.

c. A **tested and exercised early warning system** enabling prompt responses based on actionable information.

d. A **Space Weather Service Network** supporting **research and development** (R&D) => **R2O(2R)**

e. End-to-end space weather data utilisation and simulation **system**.

All space weather data from S2P activities will be available for scientific research!

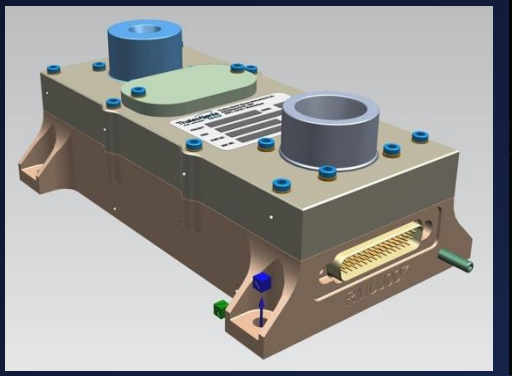
Space Weather in S2P: Hosted Payloads (D3S)

Implemented missions:

- SOSMAG/GK2A
- NGRM/EDRS-C
- ICARE-NG/HOTBIRD
- MiniRMU/Lunar Pathfinder (launch 2025)
- ERSA/Lunar Gateway (launch 2026/2027)
- Collaboration with EUMETSAT for radiation monitors onboard Sentinel-6, MTG, Metop-SG

Proposed new missions:

- Procurement of high TRL instruments for HP missions
- IOD of novel instruments
- SOSMAG-2 (collaboration with KMA GK5 mission)
- Collaboration with KASA for the L4 mission

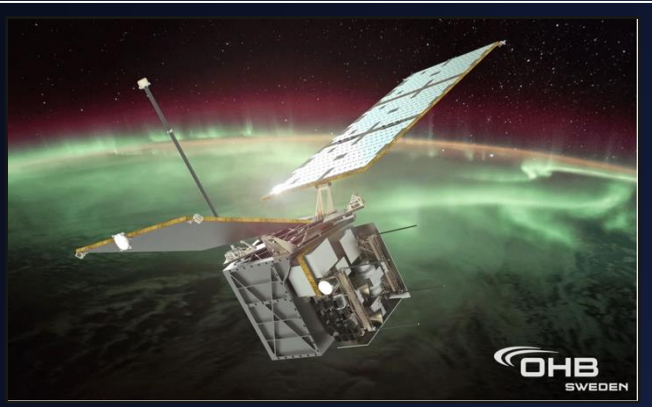


Data from Hosted Payload Missions

Instrument	Hosting flight	Orbit (altitude in km / longitude in º)	Launch Date	Mission Lifetime
SOSMAG	GK-2A	GEO (128° East)	2018	10 years
NGRM	EDRS-C	GEO (31° East)	2019	10 years
NGRM	Sentinel-6A	LEO (1336 km, 66° incl)	2020	7 years
ICARE-NG	HB 13F & 13G	GEO (13° East)	2022	10 years
NGRM	MTG-I1	GEO (0°)	2022	8.5 years
NGRM	MTG-S1	GEO (0°)	2025 (planned)	8.5 years
NGRM	Metop-SG-A1	LEO (~830 km, SSO)	2025 (planned)	7 years
NGRM	Metop-SG-B1	LEO (~830 km, SSO)	2026 (planned)	7 years
MiniRMU (same data as NGRM)	Lunar Pathfinder	Lunar (elliptical)	2026 (planned)	8 years
ERSA (SREM, NGRM, ICARE-NG, MAGIC)	Lunar Gateway	Lunar (NRHO)	2026 (planned)	5+ years
NGRM	Sentinel-6B	LEO (1336 km, 66° incl)	2026 (planned)	7 years
NGRM	MTG-I2	GEO (0°)	2026 (planned)	8.5 years
***SOSMAG-II,* next ICARE-NG, MiniRMUs…**	***Magnetometer: GK5, Radiation Monitor*: MTG-I3, MTG-2, MTG-I4, Metop-A2, Metop-B2, Metop-A3, Metop-B3, 6xGalileo-SG *Plasma Monitor:* 6x Galileo-SG *and TBDs***	***GEO, LEO, and TBDs***	***2026+***	

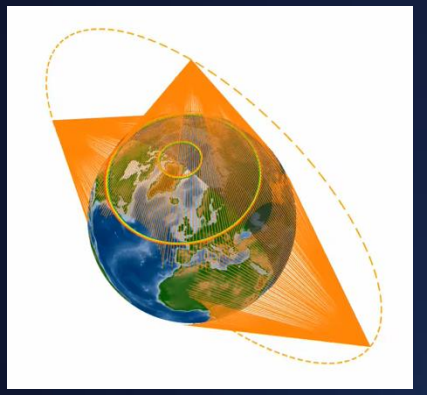
Space Weather in S2P: Aurora (D3S)

Mission concept
- Circular Medium Earth Orbit ~6500 km
- 1 satellite (Aurora-D)
- 4 satellites (Aurora-C)



Mission Duration
- Aurora-D: 1 year (+ potential extension)
- Aurora-C: 3 years

Launch dates:
- Aurora-D: 2029
- Aurora-C: 2032+



Payload
- Auroral Optical Spectral Imager (AOSI)
- Auroral Far UV Imager (AUI)
- Radiation Monitor and Magnetometer (RadMag)

Imagery of Auroral Oval

- Refreshed image every 20-30min
- SSD 30km at nadir, 100km at edge
- “wide” FoV

Optical Imaging:
- Intensities of multiple lines between 350-750nm

Far UV Imaging:
- 2 spectral bands within Oxygen lines or LBH-L and LBH-S

In-Situ Measurements

Radiation monitors: (3 directions TBC)
- proton flux (3.5 – 400 MeV, 11 channels)
- electron flux (0.3 – 5 MeV, 6 channels)
- Heavy ions particle count

Fluxgate magnetometer:
- Magnetic field vector (<10 nT accuracy)

Space Weather in S2P: Nanosatellite missions (D3S)

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 of 1st mission: SWING

- High energy Proton and Electron flux
- Solar X-ray spectrum
- 3D electron density in the ionosphere
- Ionospheric Radio Occultation

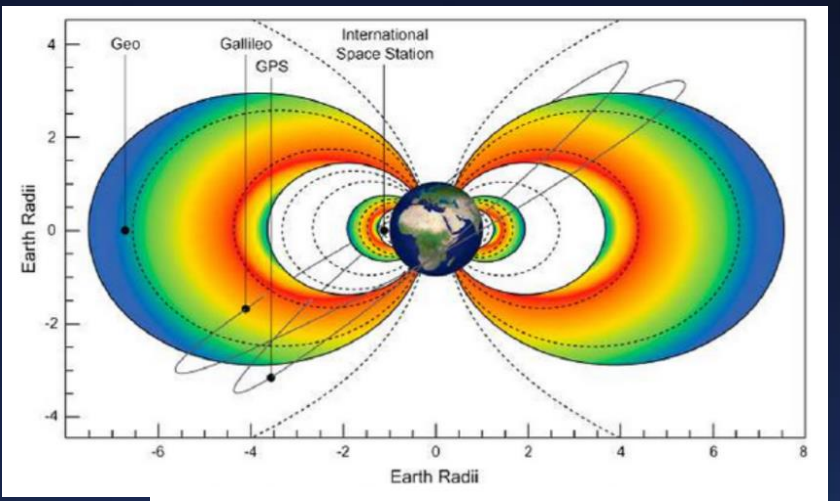
Status:

- Phase A/B/C/D/E1 started
- **Launch target: 2026**
- 2nd complementary nanosat mission in preparation => launch **2027**

Space Weather in S2P: SWORD (D3S)

Mission:

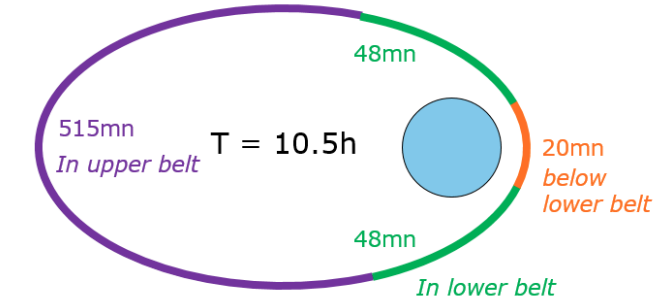
- GTO like orbit, inclination between 0-15 degree
- 2 satellites separated by half-orbit
- Slow rotation to sample pitch-angle distribution
- Low latency <60 minutes (goal of <5 minutes)
- High availability (>90%)
- Lifetime 2 (3) years – to be regularly replenished

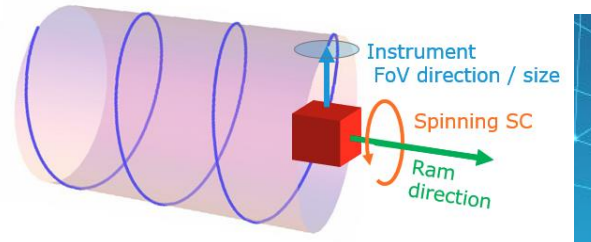


Payloads:

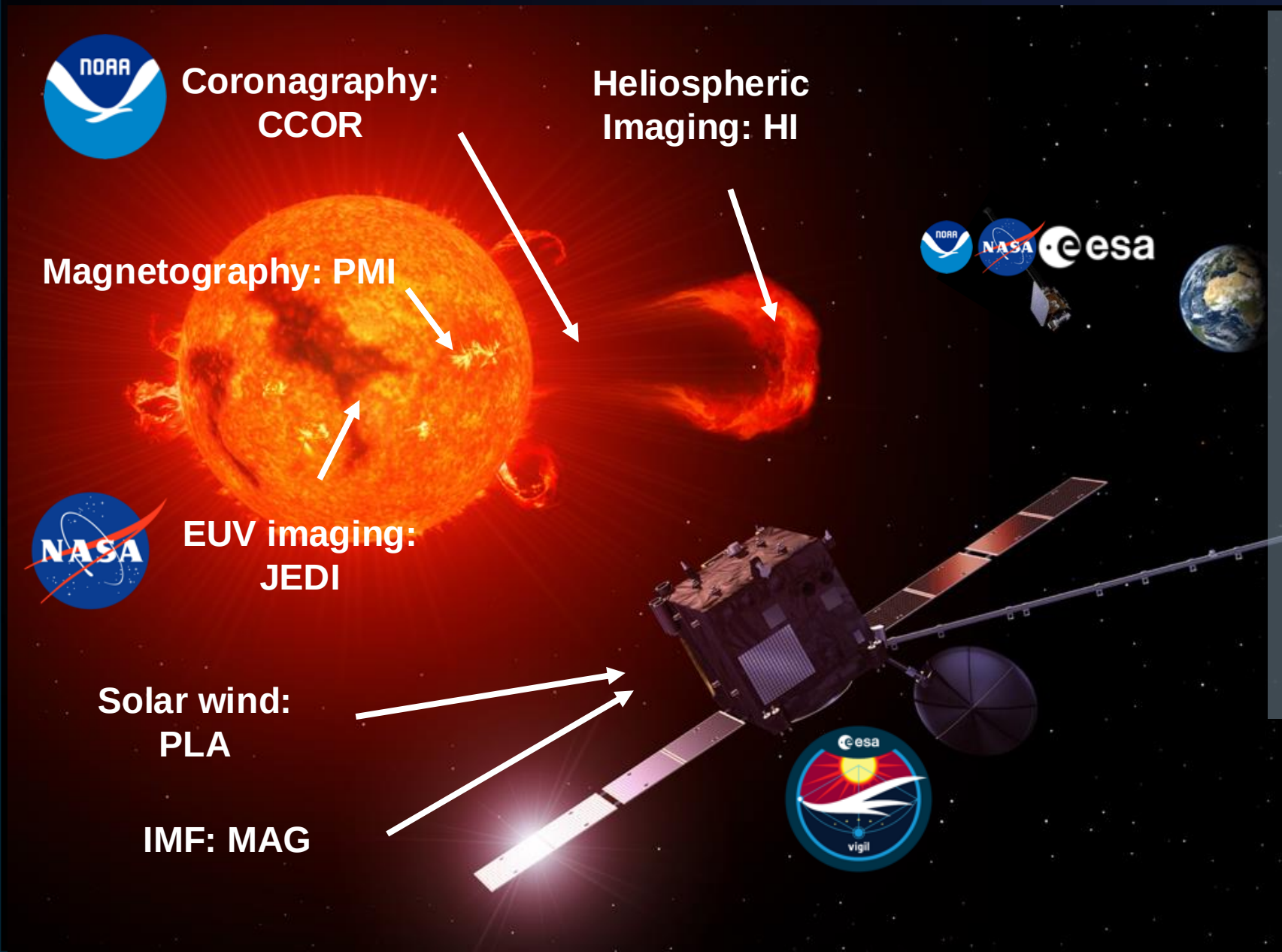
- High energy radiation monitor
- Medium energy particle instrument
- Magnetometer
- Plasma monitor (optional)
- Langmuir Probes (optional)

Orbit





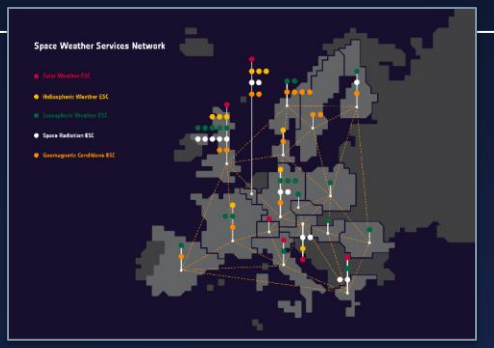
Space Weather in S2P: Vigil

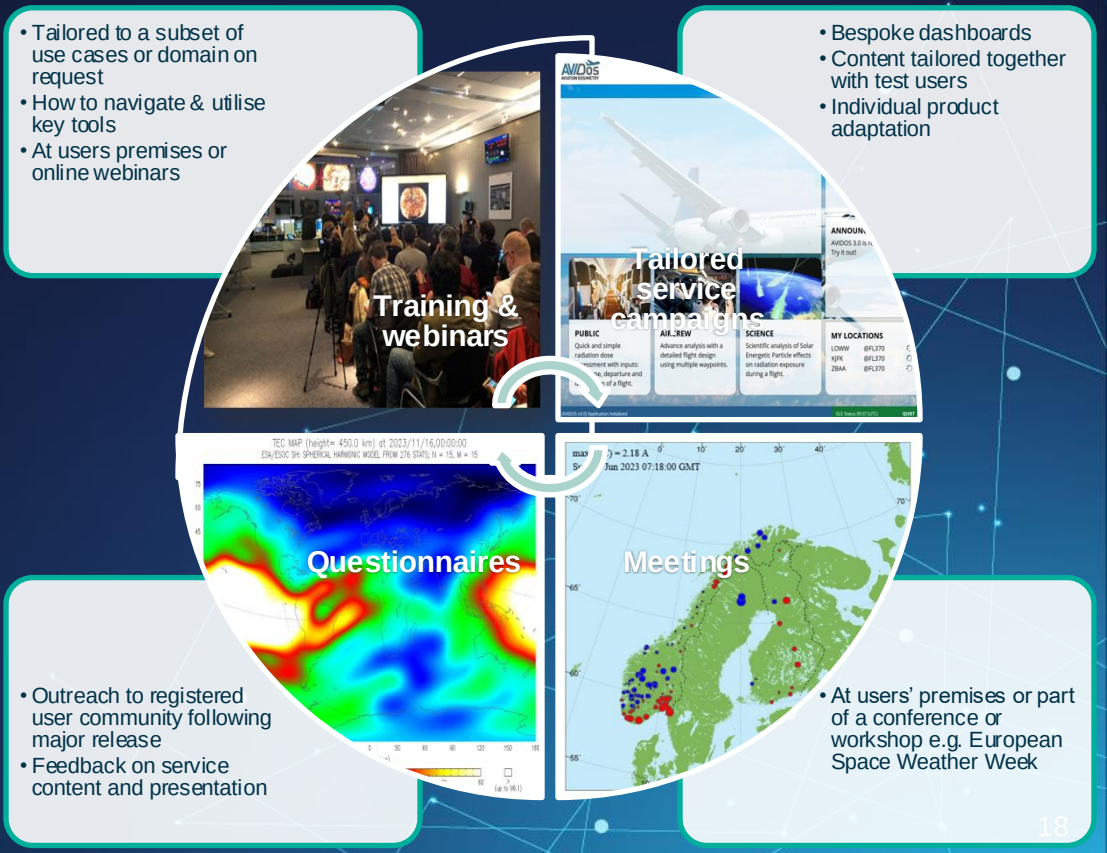


- Launch: **2031**
- Phase B2/C/D/E1 contract signed with Airbus
- All baseline instrument developments contracted
- CCOR-3 agreement with NOAA
- NASA EUV imager confirmed: **JEDI (J**oint **E**UV coronal **D**iagnostic **I**nvestigation**)**

Space Weather in S2P: Space Weather Service Network

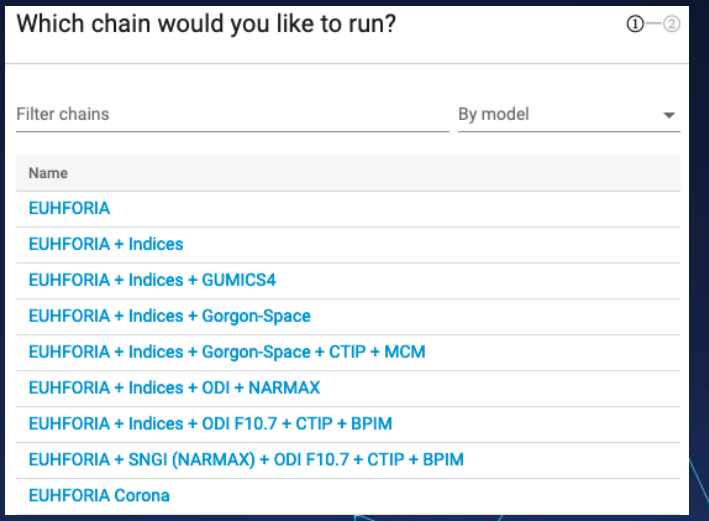
- Provision of increasingly mature pre-operational services
- Preparation of transition of mature services to operational framework
- Further development of R2O(2R) capability with coordinated performance assessment campaigns, validation and verification
- Evolution of the Service Portal based on SWE Service Network Review recommendations
- Development of new and improved user-focussed products and toolkits

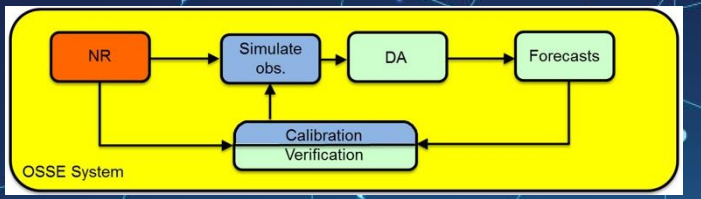


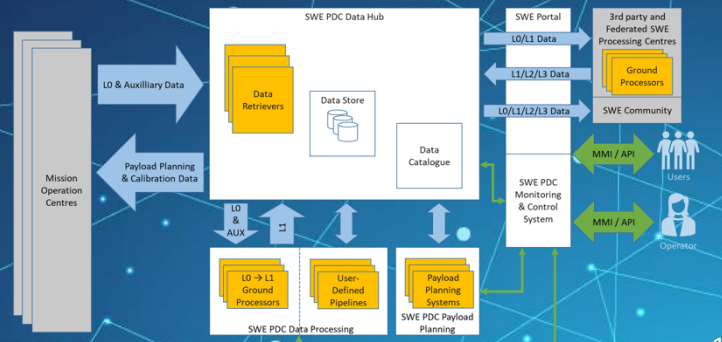


Space Weather in S2P: Core Space Weather

- Enhancement of **end-to-end space weather modelling** capability: **Virtual Space Weather Modelling Centre (VSWMC)**
- Enhancement of European space weather models to
  - ➢ **utilise data** from coming space weather missions
  - ➢ taking advantage of **scientific progress** in **space physics**, **deep learning** and **artificial intelligence** towards operational readiness => **R2O(2R)**
- Investigation of utilising **onboard data processing** including deep learning techniques
- Execution of **Observation System Simulation Experiments** (OSSE) and **Observation System Experiments** (OSE)
- Operation and evolution of **Space Weather Payload Data Centre (PDC)** and **Data HUB**







THANK YOU

www.esa.int

swe.ssa.esa.int

@esaspaceweather

ESA Heliophysics

Update since last meeting - from Directorate of Science (D/SCI)

Matt Taylor on behalf of D/SCI Heliophysics activities

ESA Science Programme

Mission Types:

L

Large Missions (1.5 billion Euro class)

- ESA-led flagship missions
- Cadence of launches: 6-7 years

M

Medium Missions (~€650M)

- ESA-led or contribution to international collaboration
- Cadence of launches: 3-4 years

S/F

Small/Fast Missions (~€200M)

- ESA-led or contribution to Member state mission
- Can be launched as passengers with other missions

MoO

Missions of Opportunity (≤€50M)

- Non mission-critical contribution to partner-led missions

COSMIC VISION (launches spanning 2019 - 2037)

SMALL/FAST

S1 - CHEOPS
[2019]

SMILE
[2025]

F1 - Comet Interceptor
[2029]

F2 - ARRAKIHS
[2030]

MEDIUM

M1 - Solar Orbiter
[2020]

M2 - Euclid
[2023]

M3 - PLATO
[2026]

M4 - Ariel
[2029]

M5 - Enuision
[2031]

LARGE

L1 - JUICE
[2023]

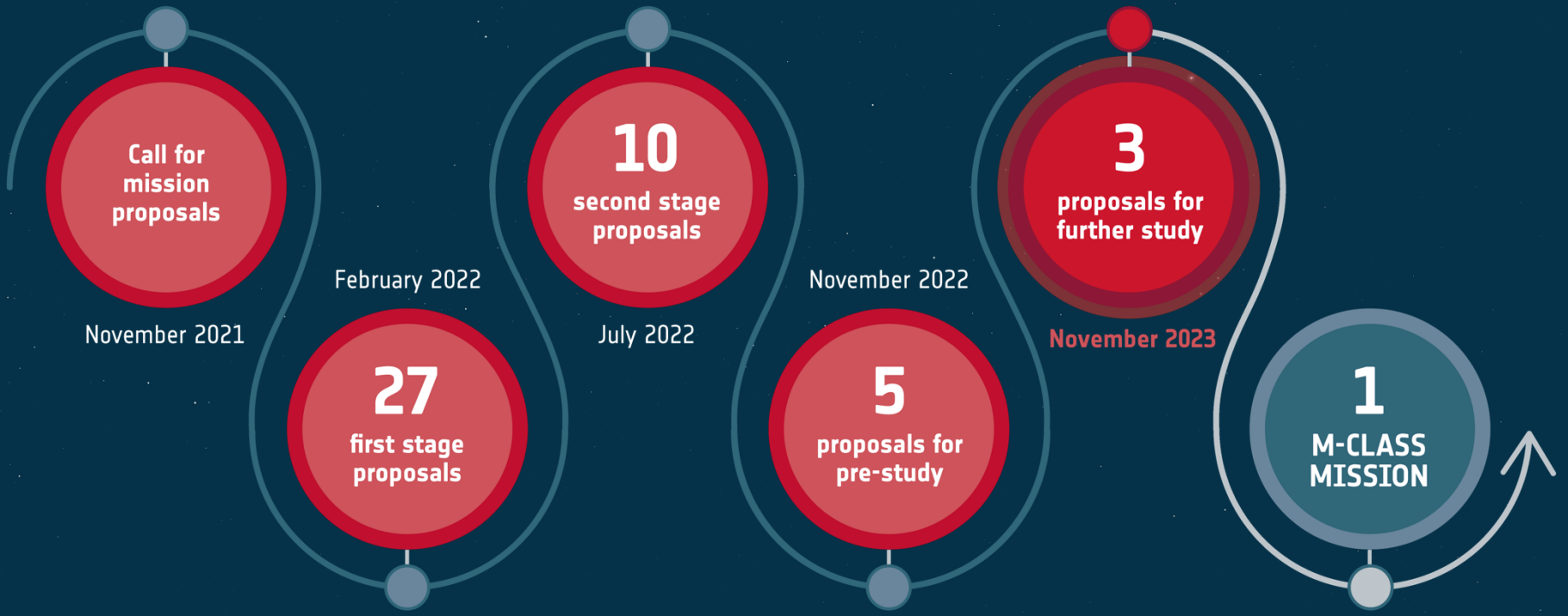
L2 - New Athena
[2037]

L3 - LISA
[2035]

in study
in development
in operations

M7 down-selection (launch 2037)

HOW ARE WE SELECTING OUR NEXT MEDIUM SCIENCE MISSION?



Selection: June 2026
Adoption: 2028
Launch: 2037

M7 Candidates selected for Phase A

M-MATISSE

Mars - **M**agnetosphere **AT**mosphere
Ionosphere and **S**pace-weather **Sienc**E

A mission proposal in answer to the ESA M-class Call Phase-2 (July 2022)

Lead proposer:

Beatriz Sánchez-Cano,
University of Leicester, United Kingdom

Co-Lead proposer:

François Leblanc,
LATMOS, CNRS, Sorbonne Université, UVSQ, Paris, France

M-MATISSE

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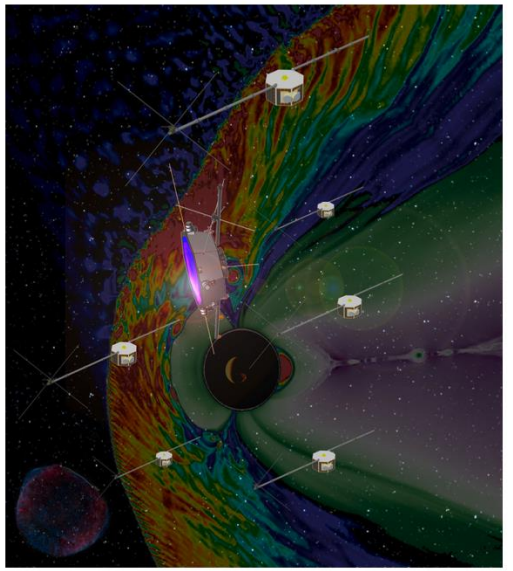
Call for a Medium-size and a Fast mission opportunity in ESA's Science Programme - 2021
M-class mission to be launched around 2037 (M7)
Phase-2 proposal

Plasma Observatory



Unveiling plasma energization and energy transport in the near-Earth plasma environment through multiscale observations

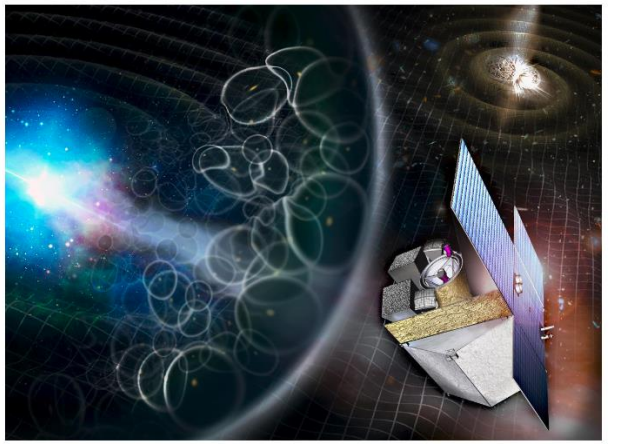
Lead Proposer: Maria Federica Marcucci

15 July 2022

Phase-II proposal for ESA Medium-class mission opportunity
(ESA Call issued on 13 December 2021)

THESEUS

Transient High-Energy Sky and Early Universe Surveyor



Lead Proposer: Dr. Lorenzo Amati (INAF - OAS Bologna, **Italy**)
Co-Leads: Prof. Paul O'Brien (Univ. Leicester, **UK**), Dr. Diego Götz (CEA/Irfu, **France**), Prof. Andrea Santangelo (Univ. Tübingen, **Germany**), Dr. Enrico Bozzo (Univ. Geneva, **Switzerland**)
Lead of USA contribution: Dr. Miles Smith (NASA/JPL, **USA**)

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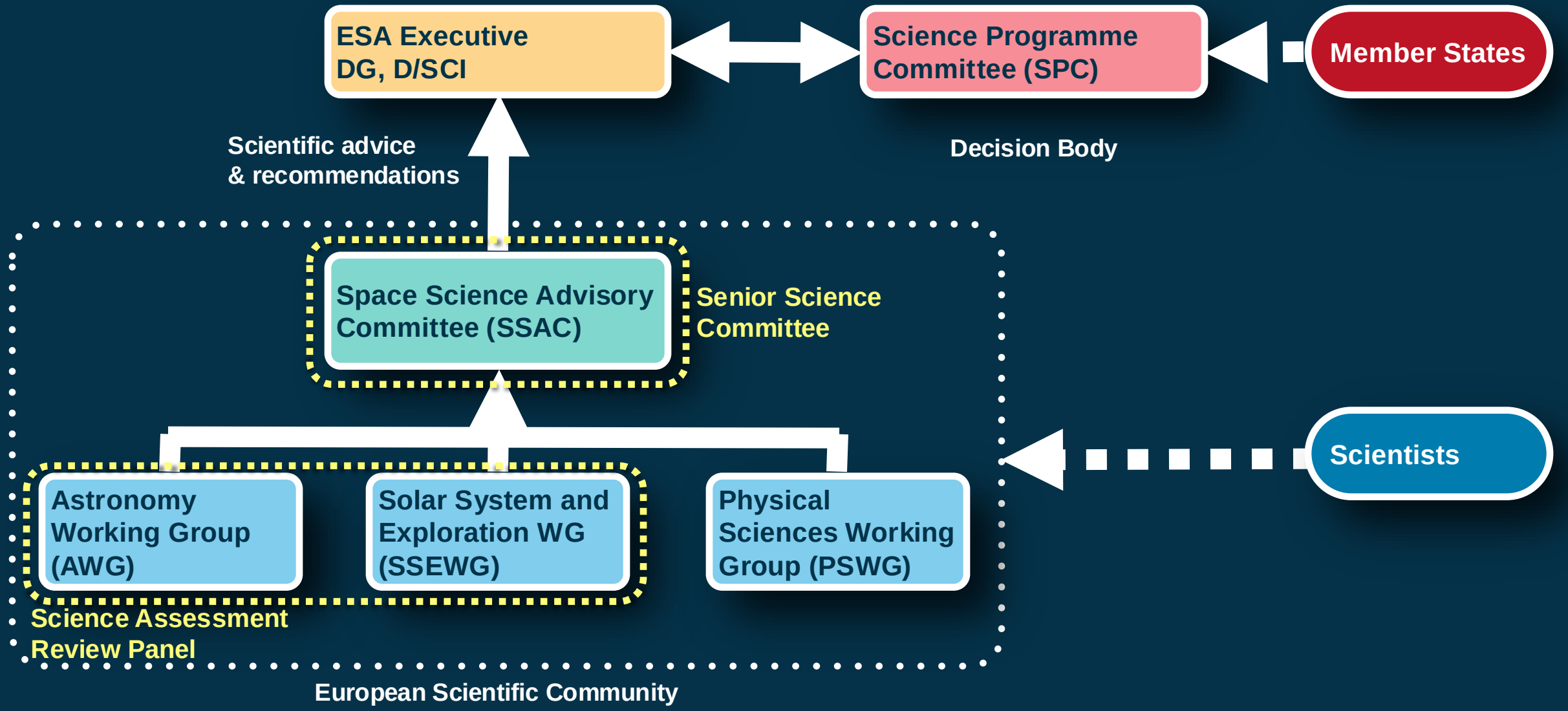
Mission selection: a bottom-up approach



https://www.cosmos.esa.int/web/call-for-missions-2025

call for a medium-size and a fast mission opportunity - 2025

Call for a Medium-size and a Fast mission opportunity - 2025 » Home

Home

BRIEFING MEETING IN ADVANCE OF NEXT CALL FOR MEDIUM AND FAST MISSIONS AND OF AN EXPLORATORY CALL FOR MINI-F PROPOSALS IN THE ESA SCIENCE PROGRAMME

ADVANCE NOTICE

12 November 2024

In order to maintain diversity, flexibility, and proper cadence of missions in the Science Programme, the Director of Science plans to issue, in March 2025, a Call soliciting the scientific community in ESA's Member States for proposals for both a Medium-class mission opportunity (M8; to be launched around 2041) and a Fast-class mission opportunity (F3; to be launched around 2034). At the same time, an exploratory Call will also be issued soliciting proposals for a new type of agile mission, referred to as mini-Fast missions.

An **online briefing to prospective proposers will be held on 11 December 2024**, to provide any necessary clarification on the scope of the proposals, the expected information, possible international cooperation schemes, possible payload provision schemes, etc. Prospective proposers should register for the online briefing in advance.

Registration for the workshop will open on this website on 4 December 2024.

To be informed about new Announcements or Calls from the ESA Science Directorate please subscribe to the dsciannounce mailing list.

Science and Research Opportunities

There is an ESA Space Science Faculty which was set up as a science forum within ESA, where ideas and views of scientists can be discussed.

https://www.cosmos.esa.int/web/space-science-faculty/about-us

This was started in the Directorate of Science, but now includes members from other directorates.

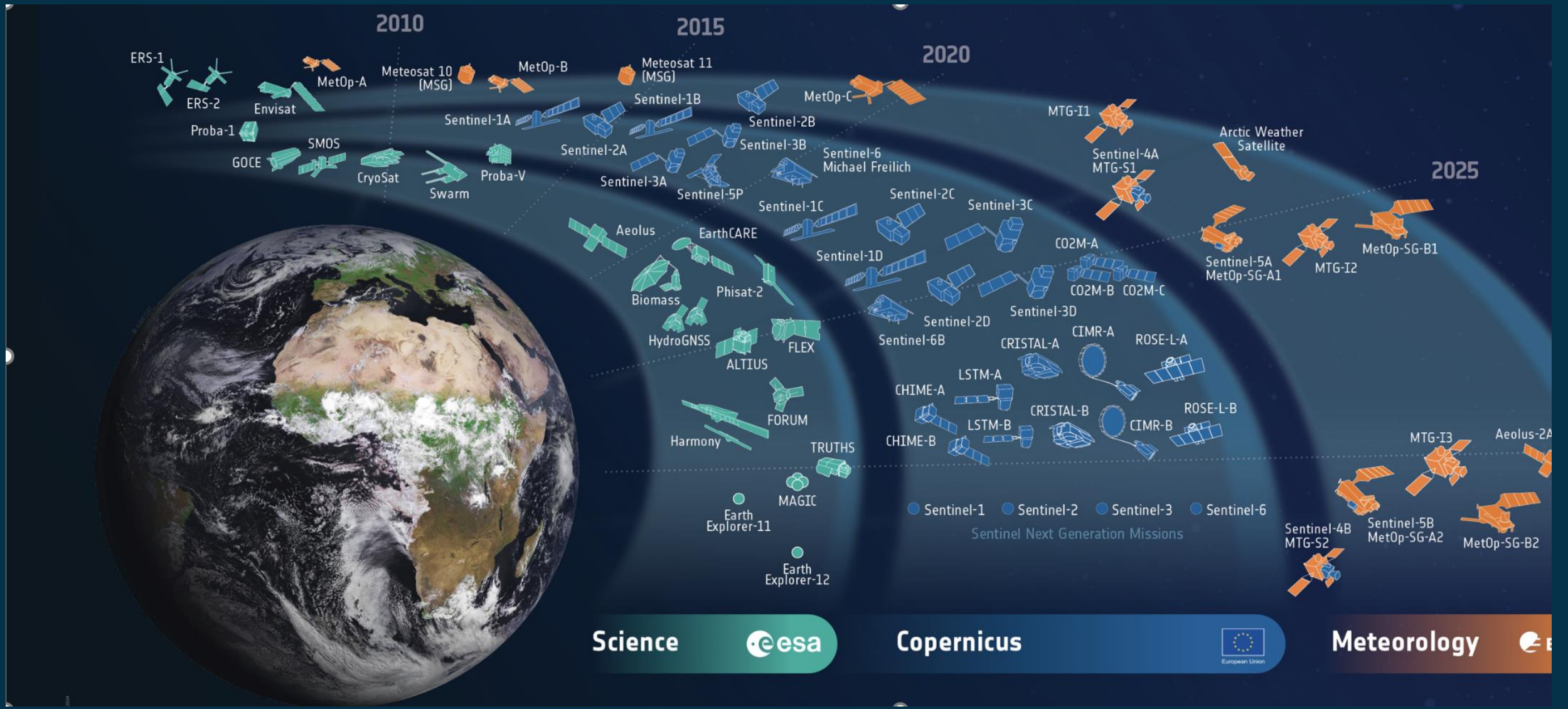
Research opportunities:

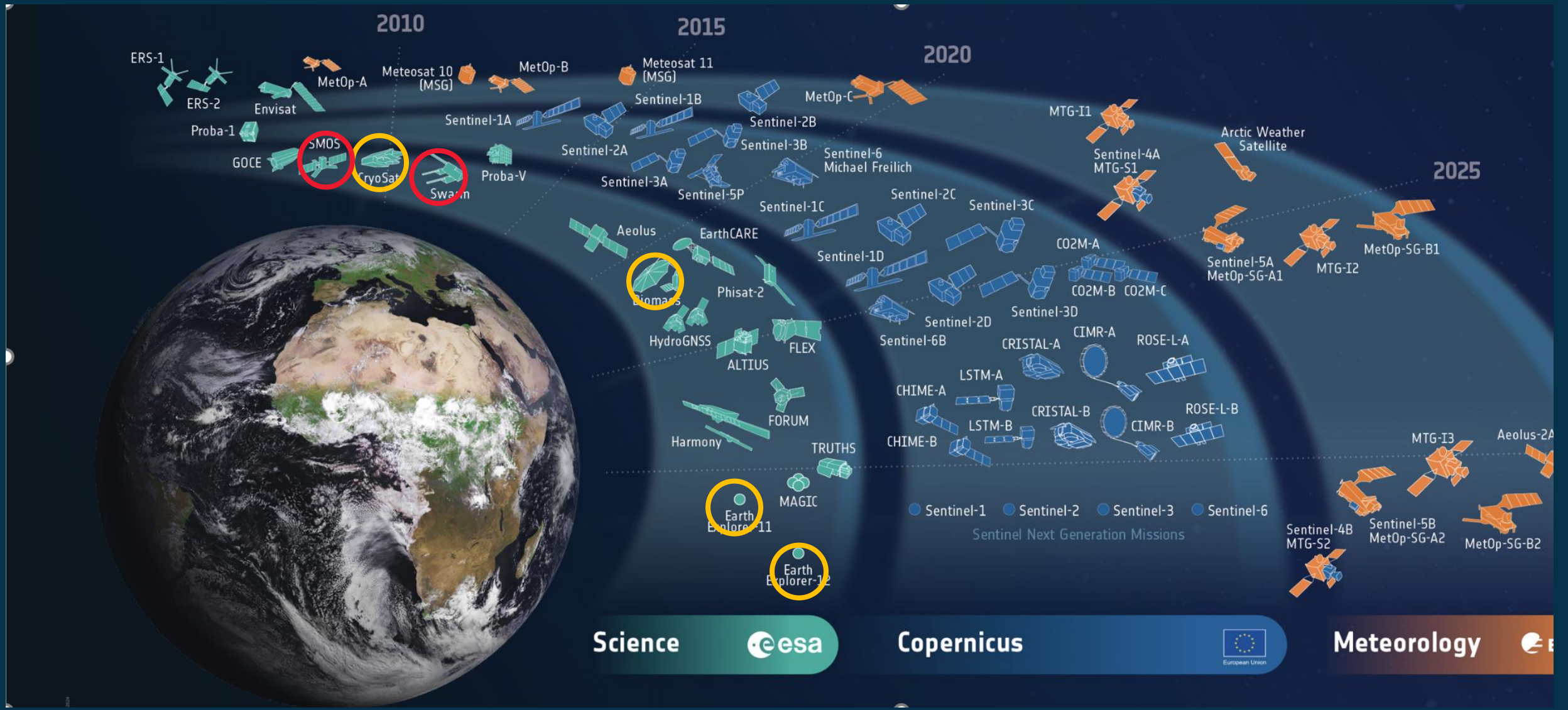
https://www.cosmos.esa.int/web/space-science-faculty/opportunities

ESA Heliophysics

Update since last meeting - from Directorate of Earth Observation (D/EOP)

Anja Stromme on behalf of D/EOP


2010
2015
2020
2025
ERS-1
ERS-2
Envisat
MetOp-A
Meteosat 10 (MSG)
MetOp-B
Meteosat 11 (MSG)
Proba-1
SMOS
GOCE
CryoSat
Swarm
Proba-V
Sentinel-1A
Sentinel-1B
Sentinel-2A
Sentinel-3A
Sentinel-5P
Sentinel-2B
Sentinel-3B
Sentinel-6 Michael Freilich
MetOp-C
Aeolus
EarthCARE
Biomass
Phisat-2
HydroGNSS
ALTIUS
FLEX
FORUM
Harmony
TRUTHS
MAGIC
Earth Explorer-11
Earth Explorer-12
Sentinel-1C
Sentinel-2C
Sentinel-3C
Sentinel-1D
Sentinel-2D
Sentinel-3D
Sentinel-6B
CO2M-A
CO2M-B
CO2M-C
CRISTAL-A
CIMR-A
ROSE-L-A
LSTM-A
CHIME-A
LSTM-B
CHIME-B
CRISTAL-B
CIMR-B
ROSE-L-B
MTG-I1
Sentinel-4A MTG-S1
Arctic Weather Satellite
Sentinel-5A MetOp-SG-A1
MTG-I2
MetOp-SG-B1
MTG-I3
Aeolus-2A
Sentinel-4B MTG-S2
Sentinel-5B MetOp-SG-A2
MetOp-SG-B2
Sentinel-1
Sentinel-2
Sentinel-3
Sentinel-6
Sentinel Next Generation Missions
Science
Copernicus
Meteorology


2010
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ERS-1
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Proba-1
GOCE
SMOS
CryoSat
Swarm
Proba-V
Sentinel-1A
Sentinel-1B
Sentinel-2A
Sentinel-3A
Sentinel-5P
Sentinel-2B
Sentinel-3B
Sentinel-6 Michael Freilich
MetOp-C
Sentinel-1C
Sentinel-2C
Sentinel-3C
Sentinel-1D
Aeolus
EarthCARE
Biomass
Phisat-2
HydroGNSS
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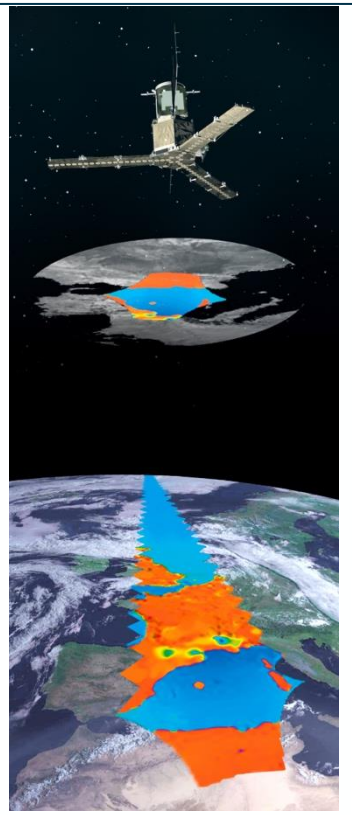
Earth Explorer-11
Earth Explorer-12
Sentinel-2D
Sentinel-6B
Sentinel-3D
CO2M-A
CO2M-B
CO2M-C
CRISTAL-A
CIMR-A
ROSE-L-A
LSTM-A
CHIME-A
LSTM-B
CHIME-B
CRISTAL-B
CIMR-B
ROSE-L-B
MTG-I1
Sentinel-4A MTG-S1
Arctic Weather Satellite
Sentinel-5A MetOp-SG-A1
MTG-I2
MetOp-SG-B1
MTG-I3
Aeolus-2A
Sentinel-4B MTG-S2
Sentinel-5B MetOp-SG-A2
MetOp-SG-B2
Sentinel-1
Sentinel-2
Sentinel-3
Sentinel-6
Sentinel Next Generation Missions
Science
Copernicus
Meteorology

SMOS Mission for Space Weather

SMOS:
Soil Moisture and Ocean Salinity. ESA Earth Explorer mission, launched in Nov. 2009, capturing brightness temperature images of Earth's surface.

Orbit:
sun-synchronous orbit (dusk-dawn 6am/6pm) at ~770 km height.

Payload:
Full Polarization L-band (1.4 GHz) **M**icrowave 2D **I**maging **R**adiometer with **A**perture **S**ynthesis (**MIRAS**).

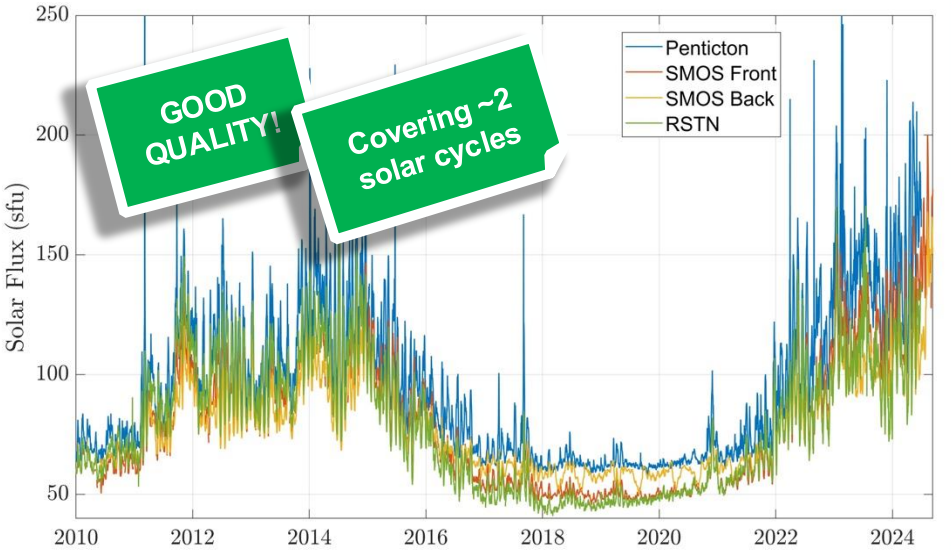


Due to antenna size and wavelength, FoV is large enough to capture full Earth-disk and part of the surrounding sky, including the Sun.

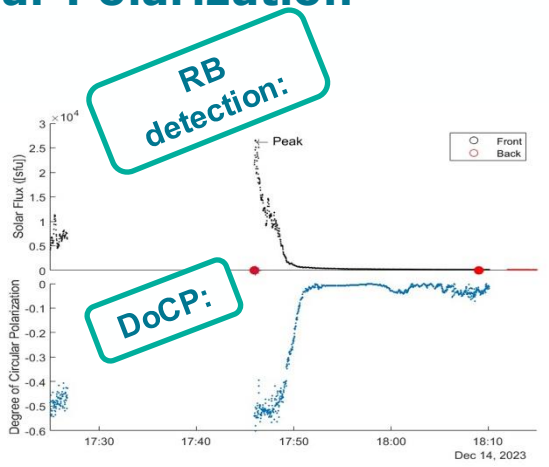
These stray solar signals are noise for Earth measurements, but valuable data for space weather science!

serco REDLAB PASSION FOR RESEARCH AND INNOVATION Team, within SMOS ESL project, developed an algorithm to:

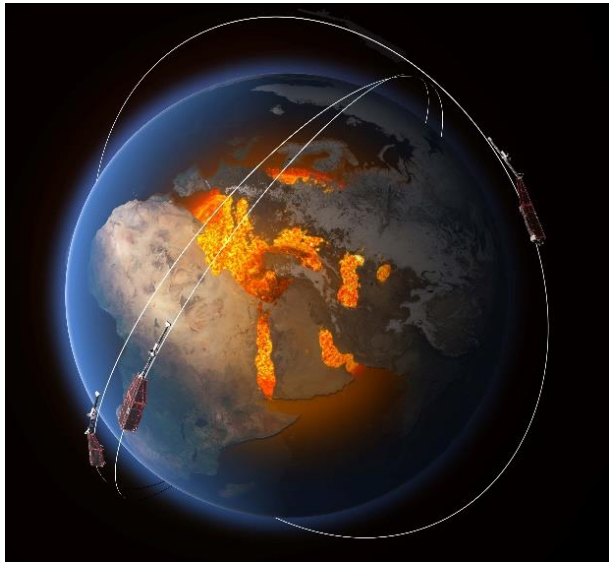
- extract **Sun BT** and **Solar Flux** From SMOS L1B (full mission available)
- automatic detect **radio burst** events (full-repro ongoing,



ar Polarization



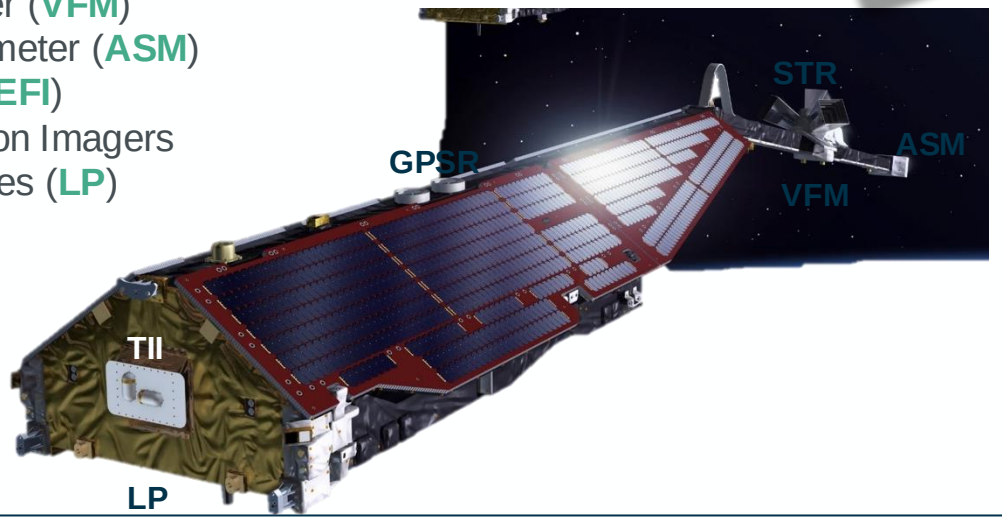
Swarm Mission for Space Weather



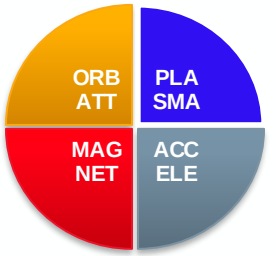
Swarm:
ESA Earth Explorer mission, launched in Nov. 2013, to monitor the Earth's magnetic and electric fields and ionospheric environment.

Orbit:
Constellation of 3 satellites, A and C flying side by side at ~470 km, B flying at ~510 km with drifting orbit.

Payload:
- Vector Field Magnetometer (**VFM**)
- Absolute Scalar Magnetometer (**ASM**)
- Electric Field Instrument (**EFI**) composed by 2 Thermal Ion Imagers (**TII**) and 2 Langmuir Probes (**LP**)
- 3 Star trackers (**STR**)
- Accelerometer (**ACC**)
- GPS receiver (**GPSR**)



OPERATIONAL CHAIN
4 processors providing data with a latency of 4 days for L1B and 5 days for L2 Cat-2 products.



A **"FAST" chain** has been developed to provide data with minimum latency wrt acquisition

Good quality data !

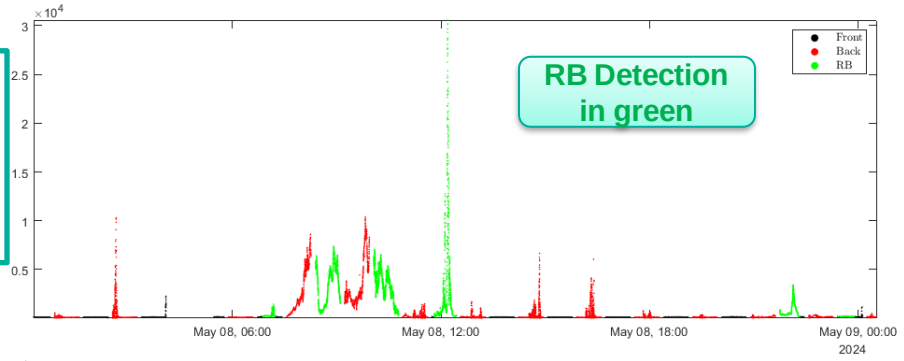
- **Same algorithms** (FAST with some alternative input files)
- **Same product types**
- **Same time resolution**
- **Reduced latency**:
  - 4 days for OPER
  - ~12 h for FAST
- **Negligible impact on orbit data determination**

- **L1B data distributed since November 2023**
- **L2 FAC distributed since June 2024**
- **L2 TEC coming very soon!**

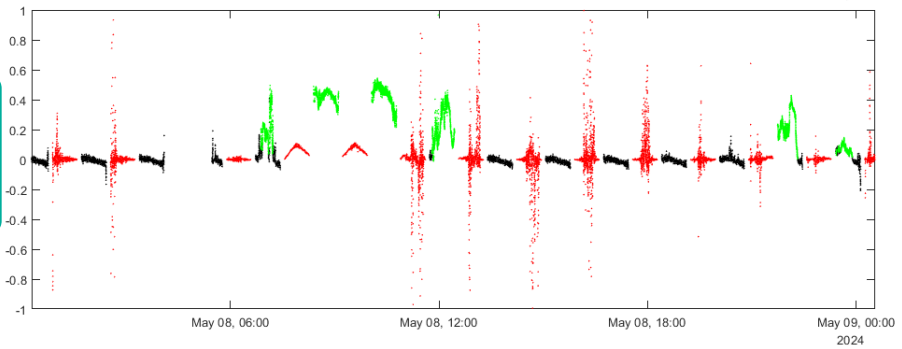
Swarm – SMOS synergies for Space Weather

May 2024 “Mother’s day” superstorm observed by SMOS and Swarm:

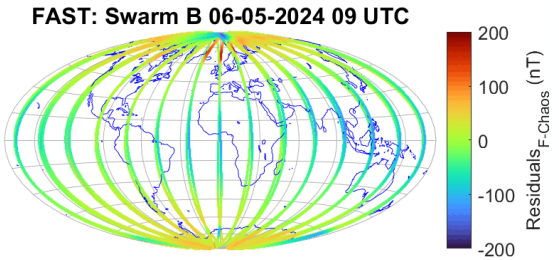
Solar flux:



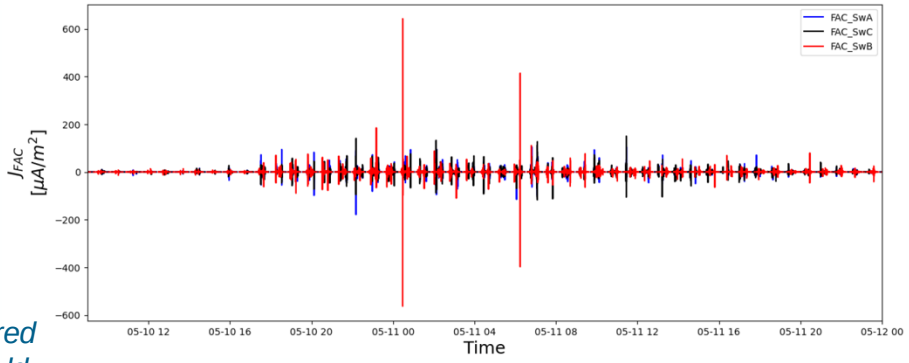
DoCP:



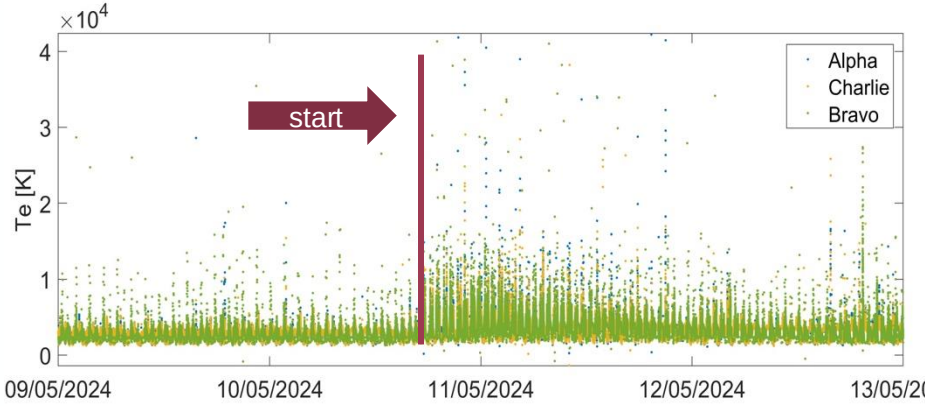
Solar flux enhancement measured by SMOS, Radio burst events detected with corresponding high degree of circular polarization



Difference between scalar magnetic field measured by Swarm-B and Chaos model for internal field. Differences are due to external fields variations.



Increase of FAC measured along Swarm orbit on 11 May 2024

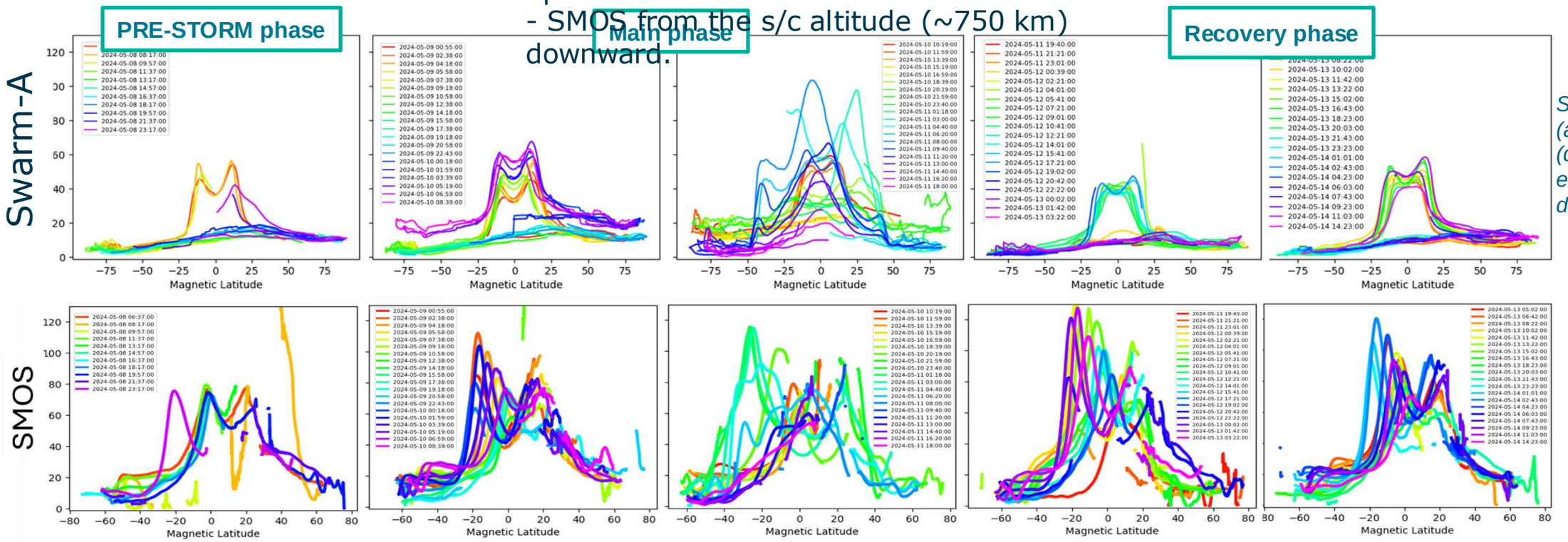


Sudden increase in plasma temperature along Swarm A, B and C orbits, starting from 10 May 2024.

Swarm – SMOS synergies for Space Weather

Both Swarm and SMOS provide measurements of Total Vertical Electron Content (VTEC), very useful to evaluate impact of Space Weather phenomena on the ionosphere:

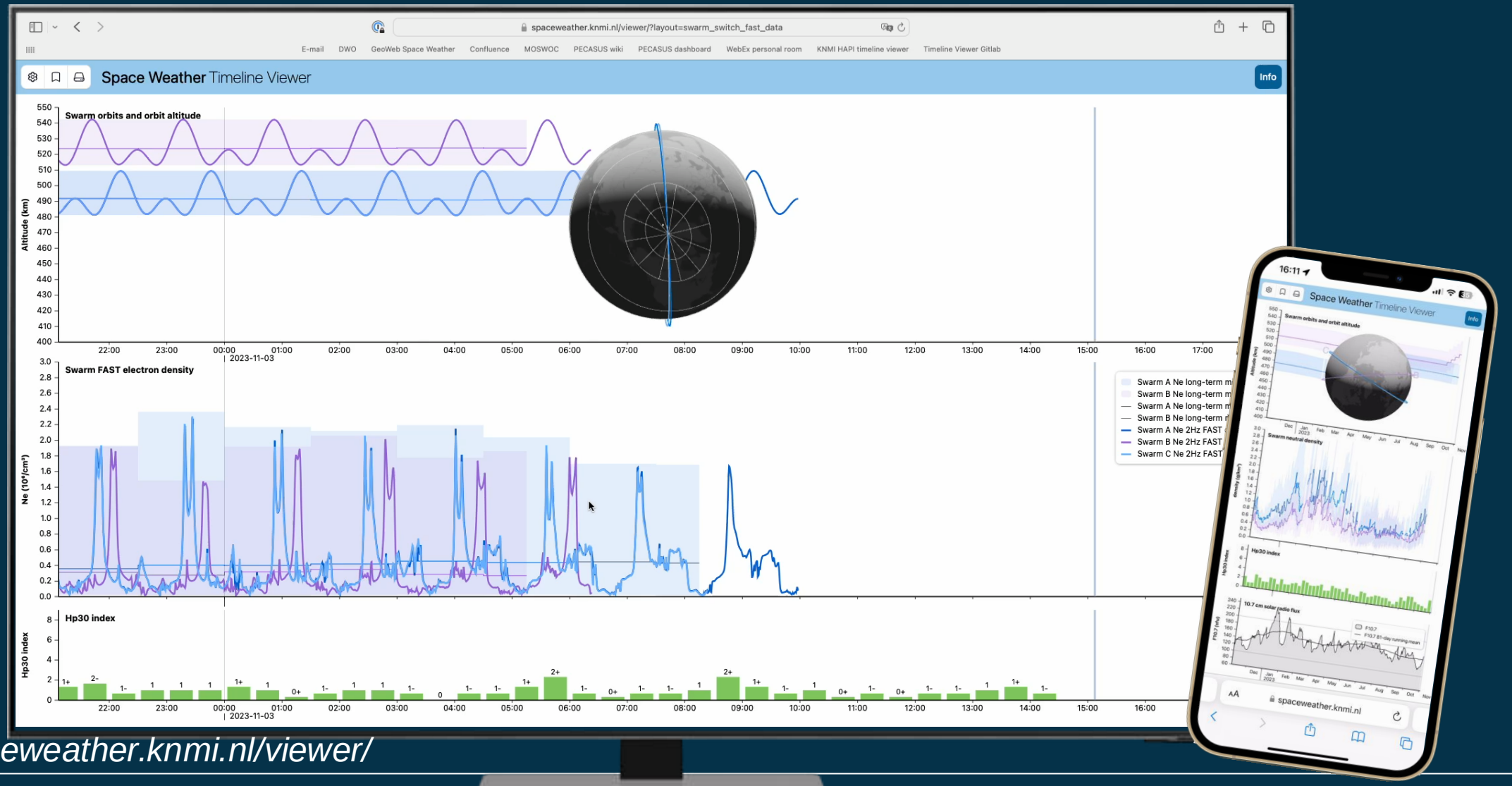
- Swarm from the s/c altitude (~500 km) upward
- SMOS from the s/c altitude (~750 km) downward.



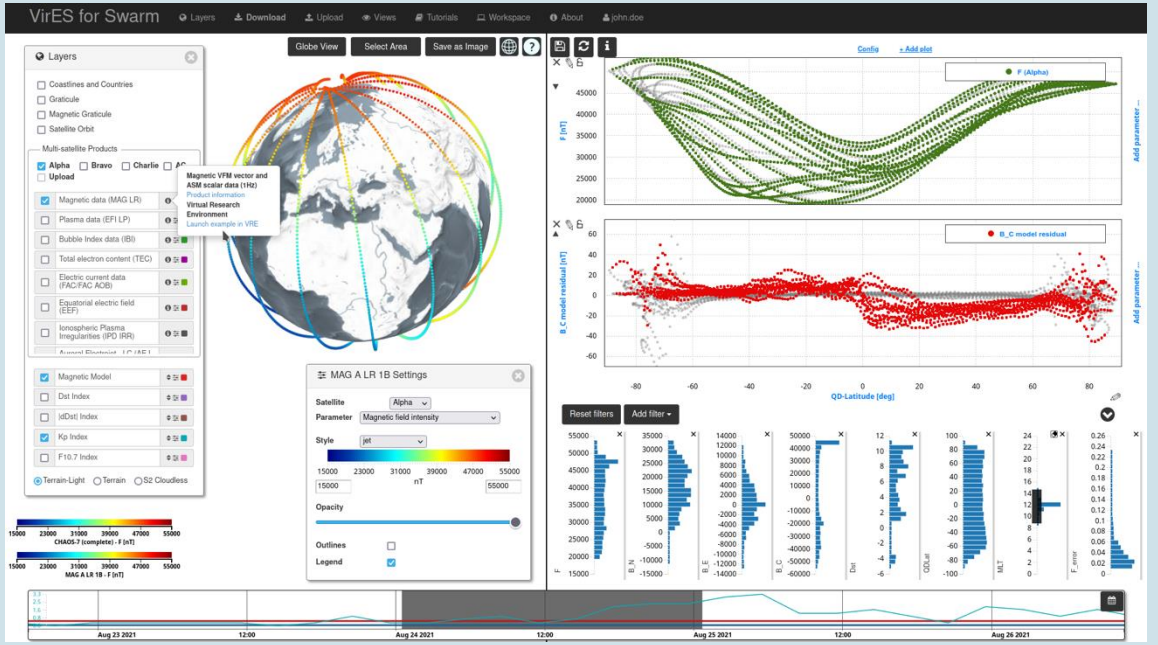
Swarm-A LT: 7 a.m. (ascending) – 7 p.m. (descending). Storm effects visible on descending orbits.

SMOS LT: 6 p.m. (only descending orbits shown here)

Swarm observations together with a large number of other sources in the KNMI Space Weather Timeline Viewer (slide from Eelco Doornbos)



https://spaceweather.knmi.nl/viewer/



VirES for (not only) Swarm

https://vires.services

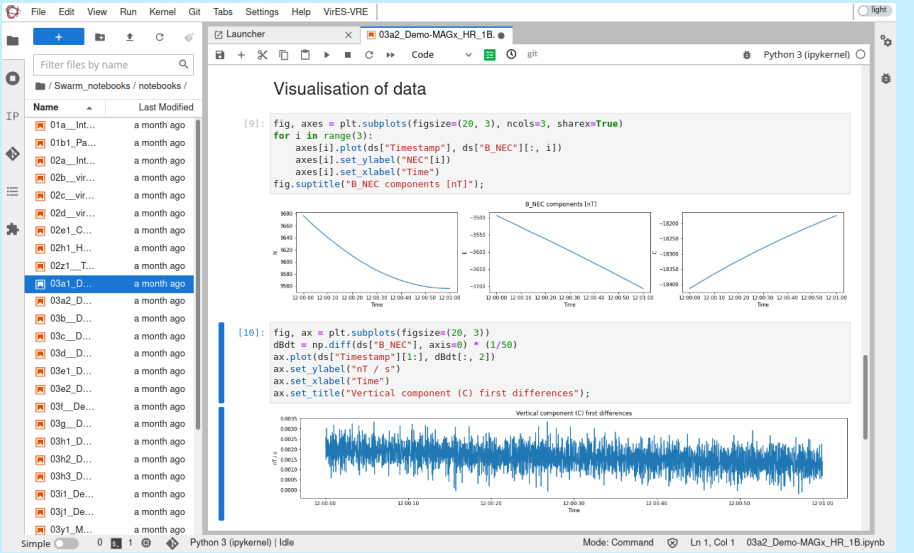
- **ecosystem of services:**
  - highly interactive web for quick data exploration
  - Jupyter-based Virtual Research Environment
  - VirES Python client for API access to data
  - Heliophysics API
- **offered data:**
  - Swarm products (L1B MAG and EFI, L2)
  - rich collection geomagnetic models (L2 SHA, CHAOS, IGRF, …)
  - calibrated measurements from CryoSat-2, GRACE-1,2 and GRACE-FO platform magnetometers.
  - INTERMAGNET ground observatory data

Virtual Research Environment

- **ready-to-use cloud execution environment**
  - access to VirES datasets
  - curated set of pre-installed libraries
  - collection of example recipes
- **allows for custom data-processing and visualization**

https://vre.vires.services

https://notebooks.vires.services



Swarm upcoming opportunities

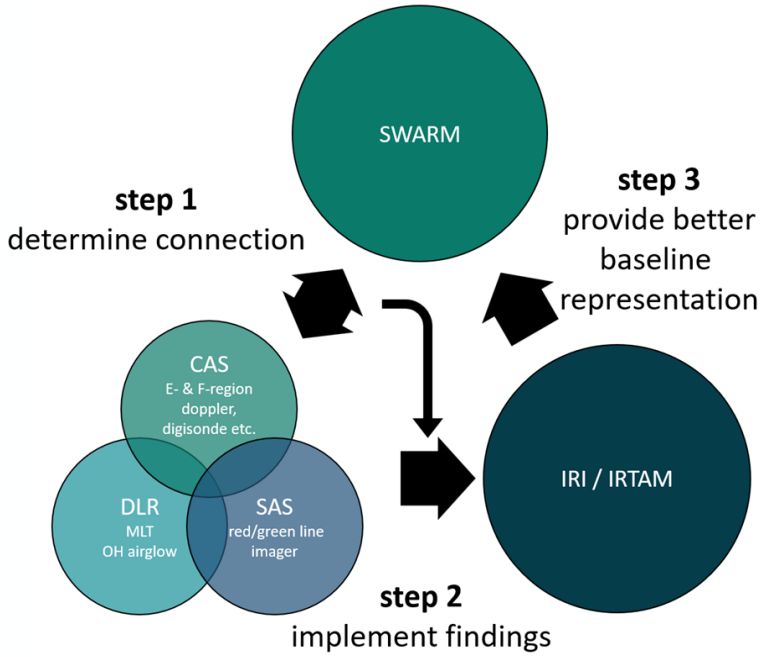
In the ESA Earth Observation “Science for Society ” framwork we are runnig 4 project related to Swarm and ionosphere/space weather, for respectively

- Quiet Ionosphere
- Dynamic Ionosphere
- Coupling down (Ionosphere-Thermosphere)
- Coupling up (Ionosphere - Magnetosphere)

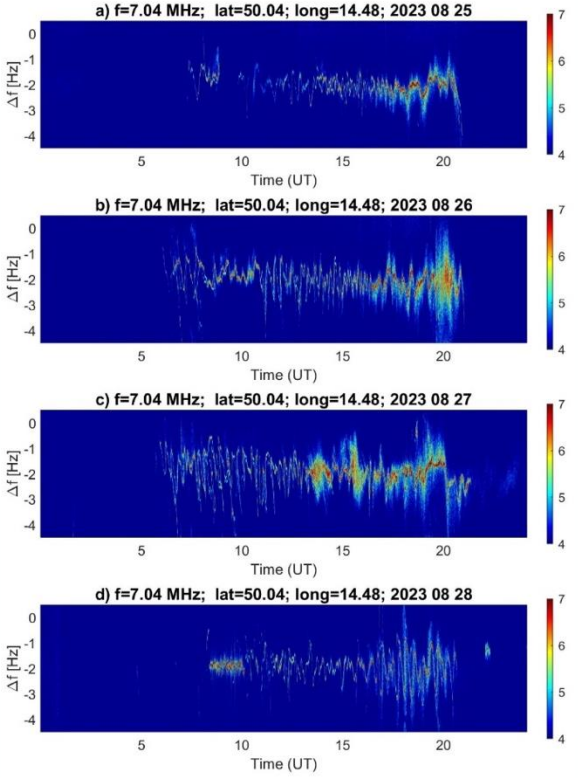
QUID-REGIS project, idea and main goals:

- Detailed study of ionospheric disturbances during quiet solar conditions
- Are unexplained ionospheric disturbances caused by certain atmospheric irregularities / waves ?
- Combined analysis of SWARM + Doppler-Sounding + Digisonde and Airglow data + IRI model

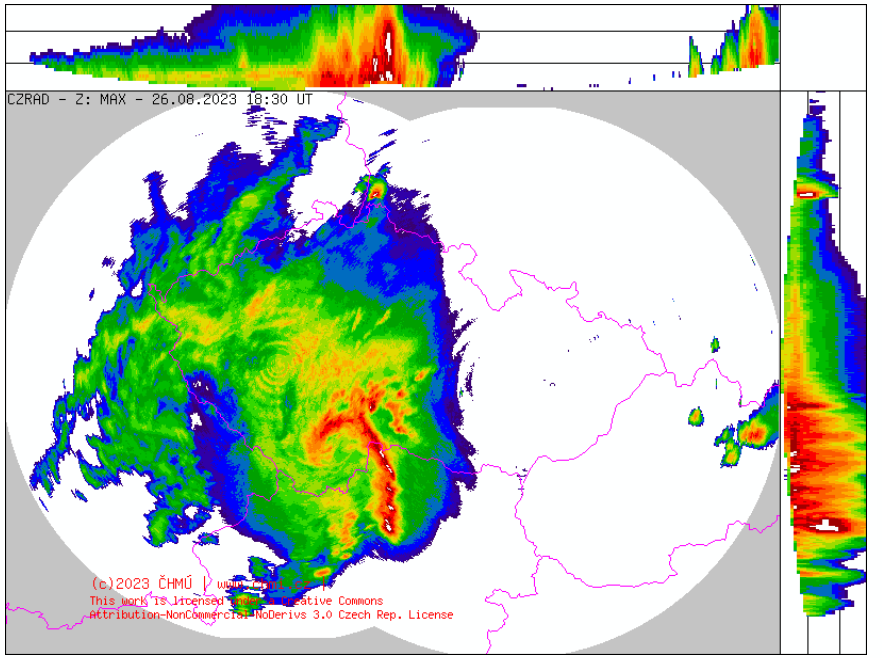
Quantitative estimation of lower atmospheric impact on the ionospheric variability during solar quiet periods



Continuous Doppler sounding data



Medium scale TIDs caused by Gravity Waves during storm systems over Europe on 26 Aug 2023 (quiet conditions Kp~2-3, Dst>-16)



Swarm-VIP-Dynamic

SWARM-VIP-DYNAMIC
SWARM SPACE WEATHER
VARIABILITY, IRREGULARITIES, PREDICTIVE CAPABILITIES FOR THE DYNAMIC IONOSPHERE

Swarm Space Weather – Variability, Irregularities, Predictive capabilities for the Dynamic Ionosphere

Objectives

1) Improved modelling method and new formulation (Table 1).
2) Ability to include thermospheric contribution ant to model small scale irregularities.
3) Ability to model the interhemispheric variability of ionospheric irregularities.
4) Thorough validation and performance assessment of the model capabilities (Figure 1), (Figure 2)

- Electron density: Taken from the IPDxIRR_2F data product.
- Grad_Ne@100km: The electron density gradient in a running window (from IPDxIRR_2F).
- RODI10s: Rate Of change of Density Index (RODI) is the standard deviation of ROD over 10 seconds (from the IPDxIRR_2F)
- p: One dimensional spectral index p. This is taken from the IPIR Faceplate dataset which was developed by Yaqi Jin during Swarm VIP Dynamic.
- RODI1s_FP: Rate Of change of Density Index (RODI) is the standard deviation of ROD over 1 seconds (16 data points for the 16 Hz electron data). This is taken from the IPIR Faceplate dataset which was developed by Yaqi Jin during Swarm VIP Dynamic.

Table 1. Choice of independent variables for the Swarm-VIP-Dynamic model.

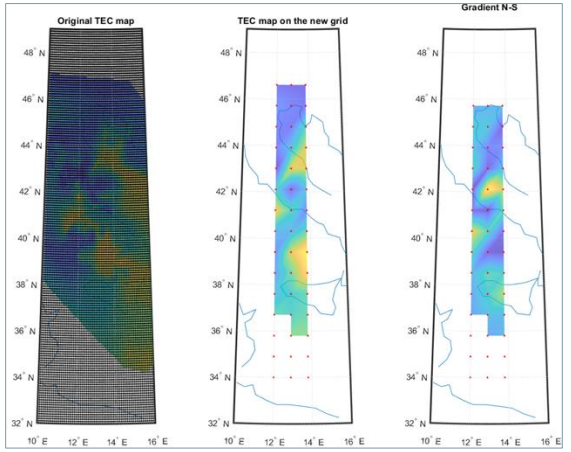


Figure 1. From Left to Right:
- Median of TEC grad N-S of all the bins in one meridian (13E longitude using 36N-46N latitude).
- Median of model output: gradNe@100km in the same geographic area.
- Comparisons generated every 15 minutes for Italy on 5-minute data range.

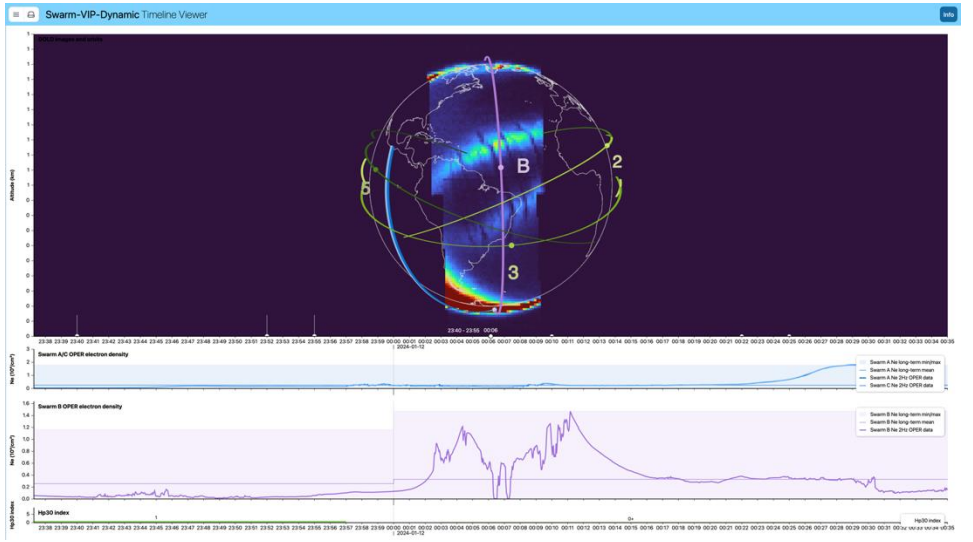


Figure 2 Timeline viewer of Swarm data which will include Swarm-VIP-Dynamic model.

JOIN

UNIVERSITY OF OULU

Joule Heating effects on Ionosphere-thermosphere coupling and neutral density

Objectives

1) Estimate the height-integrated Joule Heating in the norther hemisphere as function of time and position (Figure 1).
2) Investigate the neutral density variations during geomagnetic storms driven HSSs/SIRs or the sheath regions and MCs embedded inside the ICMEs. One of the main goals is to relate the neutral density enhancements with the storm time Joule heating observed in 1), as a large majority of the atmospheric expansion during storm times is caused by energy dissipating through Joule heating.
3) Estimate per thermospheric scale height by simultaneous neutral mass density measurements from two different altitudes (Figure 2).
4) Estimate Joule heating from incoherent scatter radar (ISR) measurements (Figure 3).

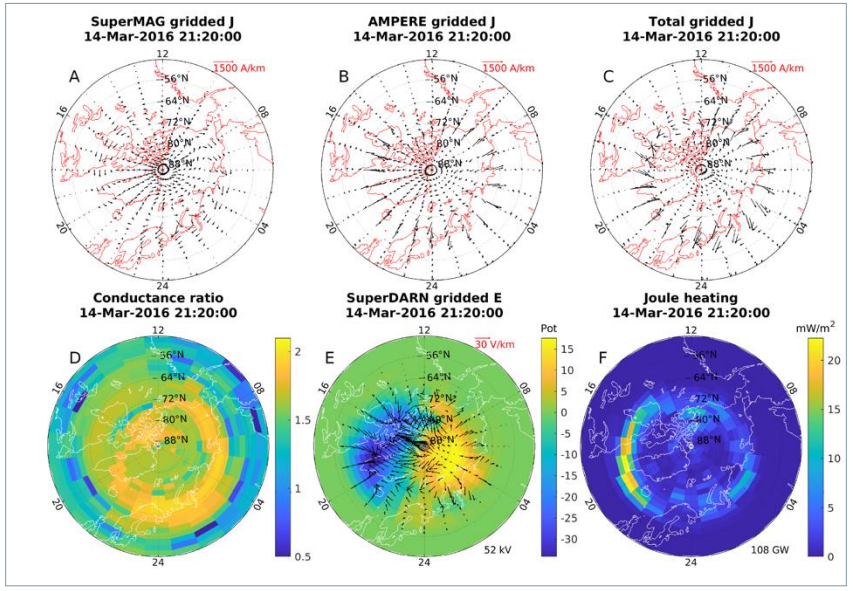


Figure 1. Example snapshot of calculating the Joule heating. Panel A shows the DF current from SuperMAG, panel B the CF current from AMPERE, panel C is their sum, panel D is the conductance ratio α, panel E shows the electric field and potential from SuperDARN, and panel F is the Joule heating calculated with Eq. (6). The cross polar cap potential and integrated Joule heating are given in panels E and F, respectively.

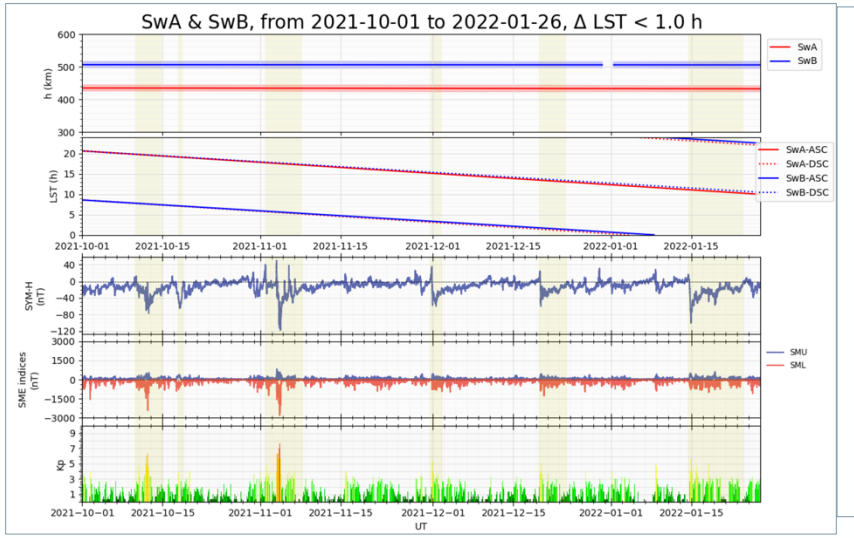


Figure 2. Coplanar period for Swarm-A/B. Panels from top to bottom are the daily mean of the orbit altitudes, of the local solar times (LST) during ascending (solid line) and descending (dotted line) phases the SYM-H index, the SuperMAG auroral electrojet indices (SMU and SML), and the Kp index. The yellow shadings mark the periods of geomagnetic storms based on the SYM-H index.

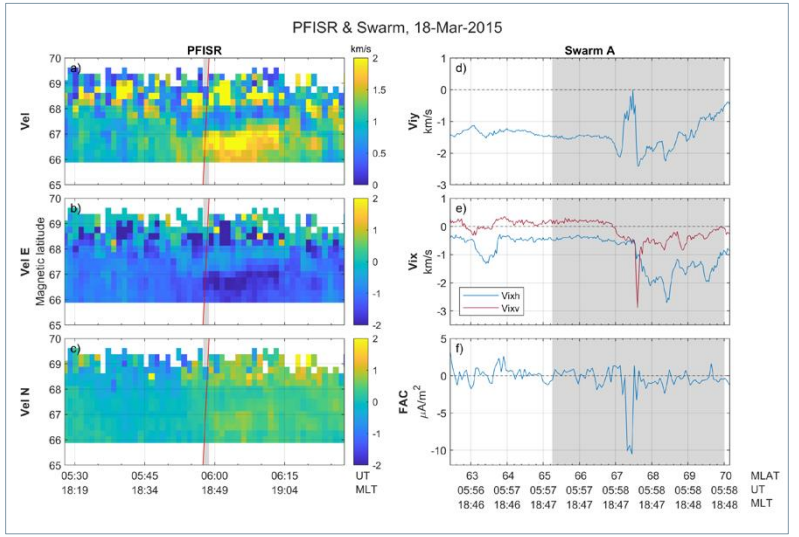
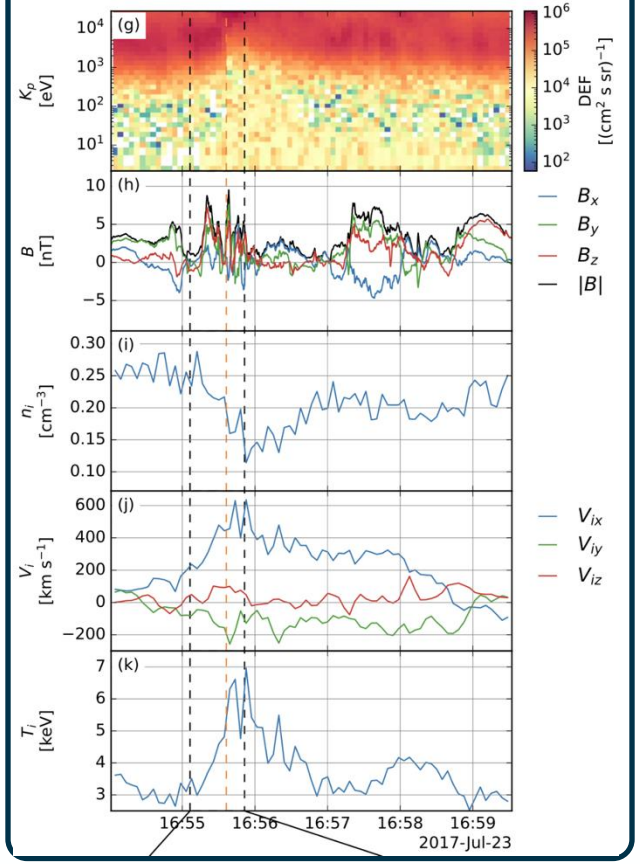


Figure 3. PFISR ion velocity and selected Swarm data for the conjunction event. Left panels show time-latitude distributions of the magnitude of ion velocity (panel a), the eastward velocity component (b) and the northward component (c) determined from the PFISR data. Time of the Swarm overpass is shown with a red line. The right panels show latitude distributions of the crosstrack (d, positive eastward) and along-track (e, positive northward) ion velocity components and the FAC (f, positive downward) measured by Swarm-A. Gray shading indicates the PFISR field-of-view.

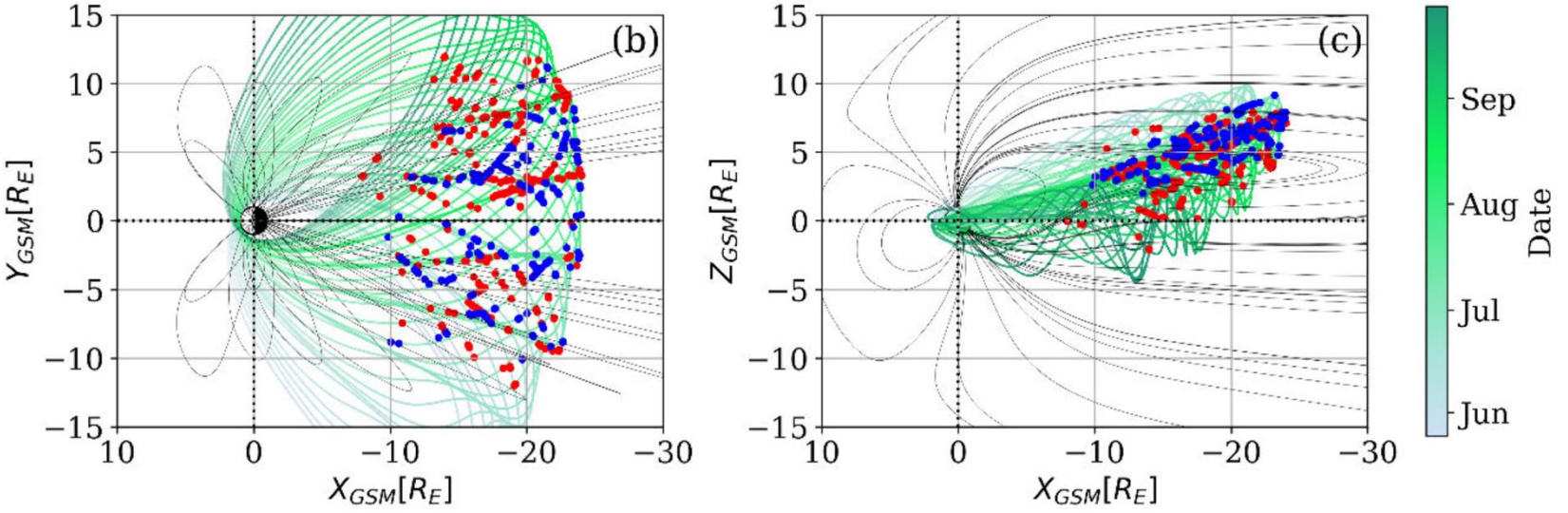
F-Burst project, idea and main goals:

- Ionosphere magnetosphere coupling: how Bursty Bulk Flows (BBF), responsible for most of transport of mass, energy magnetic flux in geomagnetic tail, affect the ionospheric / Field Aligned currents
- Combined analysis of SWARM + Cluster & MMS data

A BBF event from MMS



- Collected a statistical dataset consisting of 2135 BBF events (example on the left) observed by MMS during five magnetotail seasons (2017 to 2021)
- Tsyganenko model + upstream solar wind OMNI data to map the BBF footpoint to the ionosphere @ Swarm altitude (fig below 2nd tail season)
- Single case studies and statistical analysis are envisaged in the project



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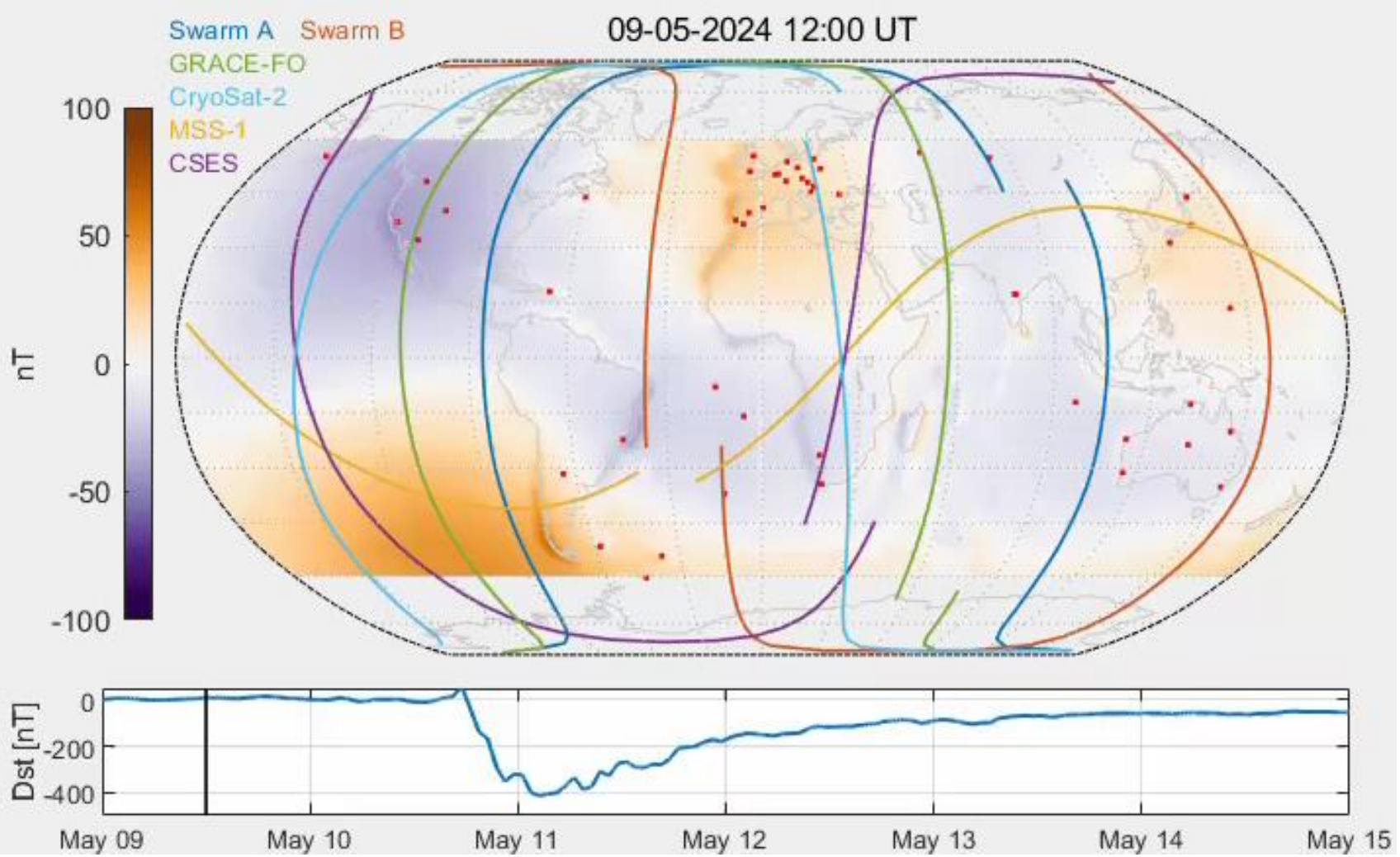
- Quiet Ionosphere
- Dynamic Ionosphere
- Coupling down (Ionosphere-Thermosphere)
- Coupling up (Ionosphere - Magnetosphere)

After their completion 2025 - 2026 the plan is to call for ~1-2 integrated “4D Ionosphere” project via open ITTs

Swarm DISC new ITTs coming soon…

Swarm DISC is in the process of evaluating the Seventh Open Call for Ideas for "New data products, tools, and services" for Swarm, a total of **12 new ideas came in**, and a subset of these will be released as open ITTs shortly.

Geomagnetic Storm of May 2024



Radial magnetic field at ground

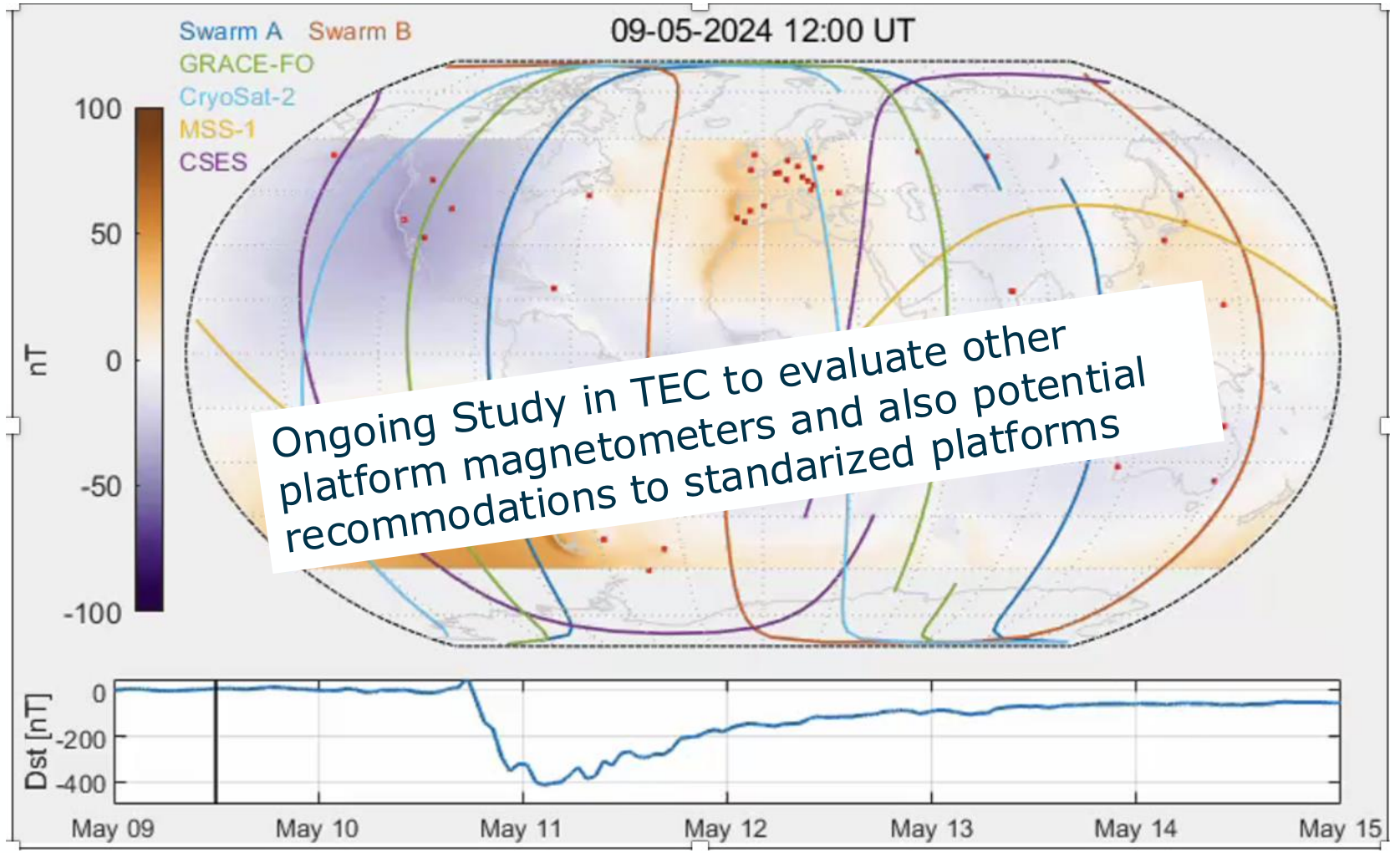
Joint analysis of ground observatory and satellite data

solving for magnetospheric, ionospheric and induced fields
for every hour

Final step: calculating induced field produced by external (magnetospheric plus ionospheric) currents using 3D conductivity model of mantle + oceans

Modelling done by
Min and Grayver, in prep. for GJI

Geomagnetic Storm of May 2024



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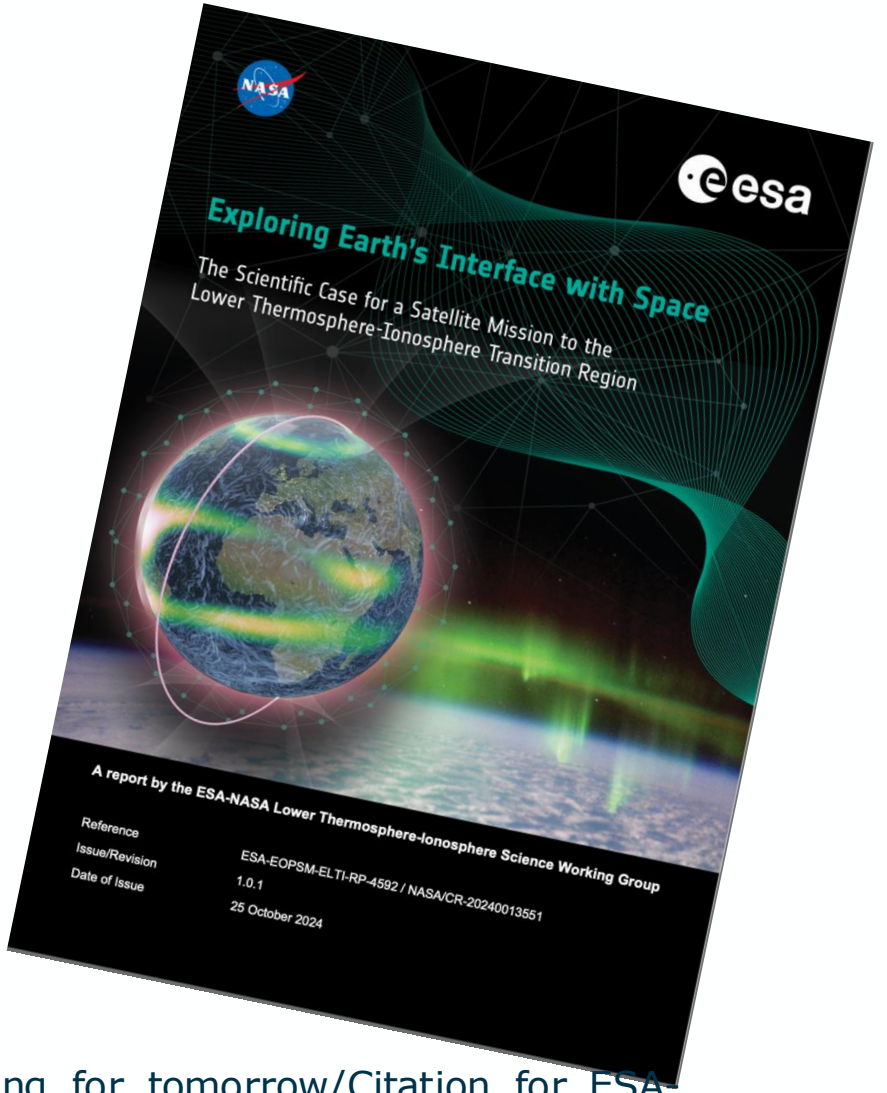
Modelling done by
Min and Grayver, in prep. for GJI

ENLoTIS (ESA-NASA Lower Thermosphere-Ionosphere Science)

The Scientific case for a satellite mission to the lower thermosphere-ionosphere transition region

SO1 Collisional Electrodynamics J	SO2 Collisional Energetics $J \cdot E$	SO3 Collisional Dynamics $J \times B$
Determine how collisions between neutral and charged species affect the electrodynamics of the LTI.	Determine how collisions between neutral and charged species affect the energetics of the LTI.	Determine how collisions between neutral and charged species affect the neutral dynamics of the LTI.
SO1.1 Determine how electric currents flow and close in the LTI, and thereby couple to the magnetospheric electrodynamics.	**SO2.1** Determine how Joule (frictional) heating depends on scale size, altitude and neutral winds.	**SO3.1** Determine how winds are accelerated by plasma motions via ion-neutral collisions.
SO1.2 Understand how the various LTI properties and processes act to determine the Hall and Pedersen conductivities.	**SO2.2** Determine how energy from energetic precipitating particles (EPP) directly heats the LTI.	**SO3.2** Discover how the exchange of momentum across scales by means of lower atmospheric forcing is manifest in the LTI.
SO1.3 Determine the effect of the neutral winds on the LTI electrodynamics.	**SO2.3** Determine how plasma-neutral collisions cause chemical changes that affect the energetics of the LTI.	**SO3.3** Determine how collisional processes drive vertical transport and cause composition changes.



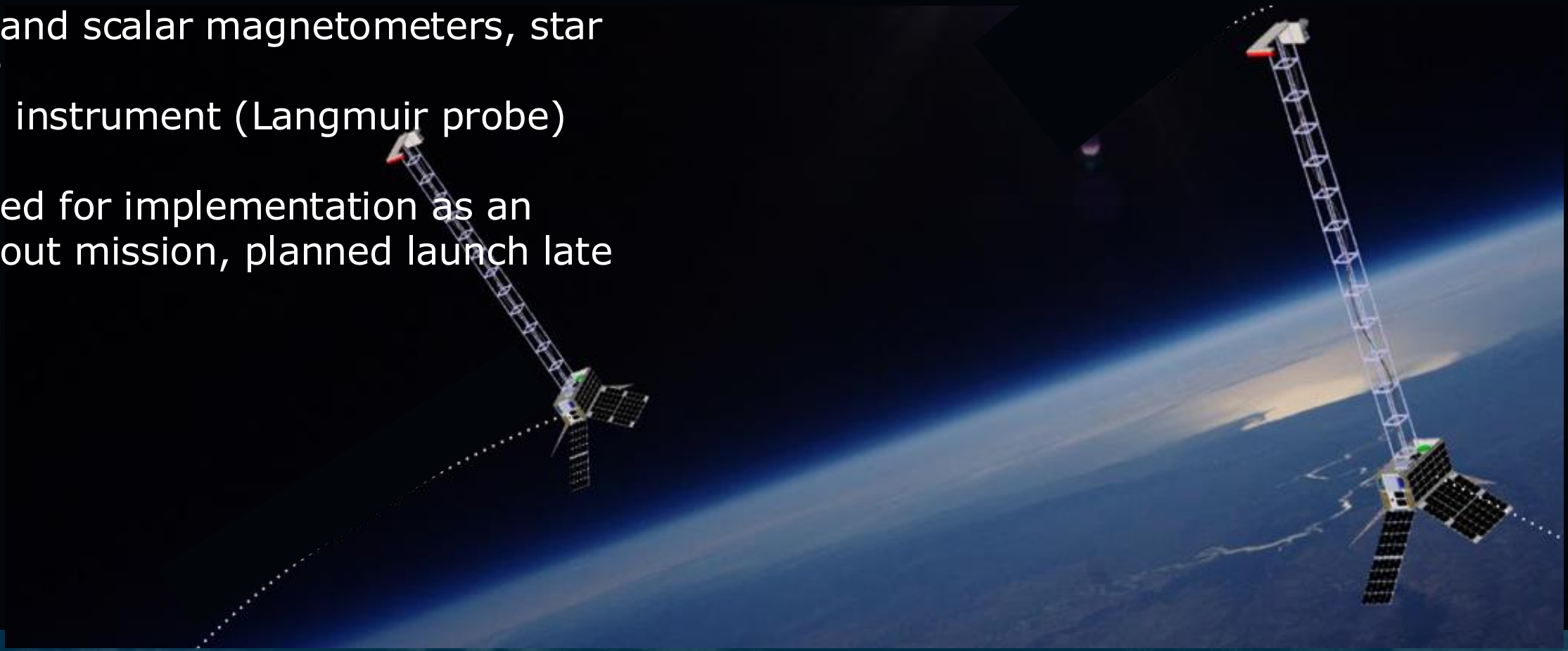
https://www.esa.int/Applications/Observing_the_Earth/FutureEO/Preparing_for_tomorrow/Citation_for_ESA-NASA_Lower_Thermosphere-Ionosphere_Science_Report

Coming soon…

NanoMagsat Constellation

- 3 cubesats (16u) at 575 km initial altitude
- Two satellites at 60° inclination, one near-polar
- Vector and scalar magnetometers, star tracker
  plasma instrument (Langmuir probe)

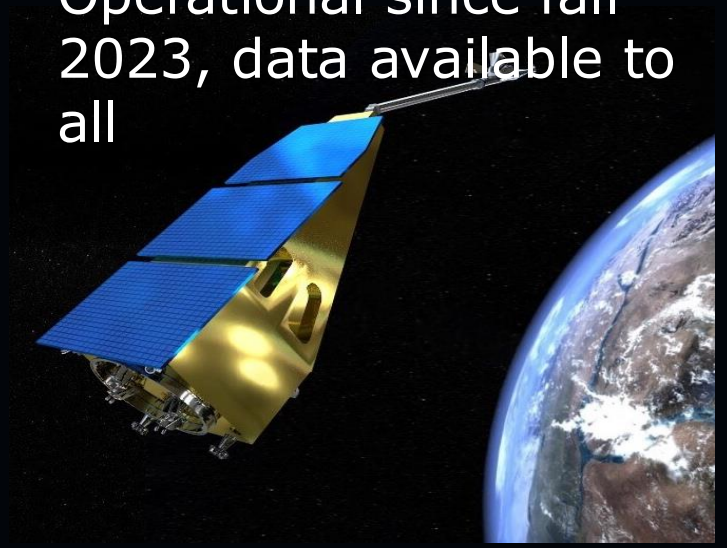
- Approved for implementation as an ESA Scout mission, planned launch late 2027



Opportunities through collaborators with Macau

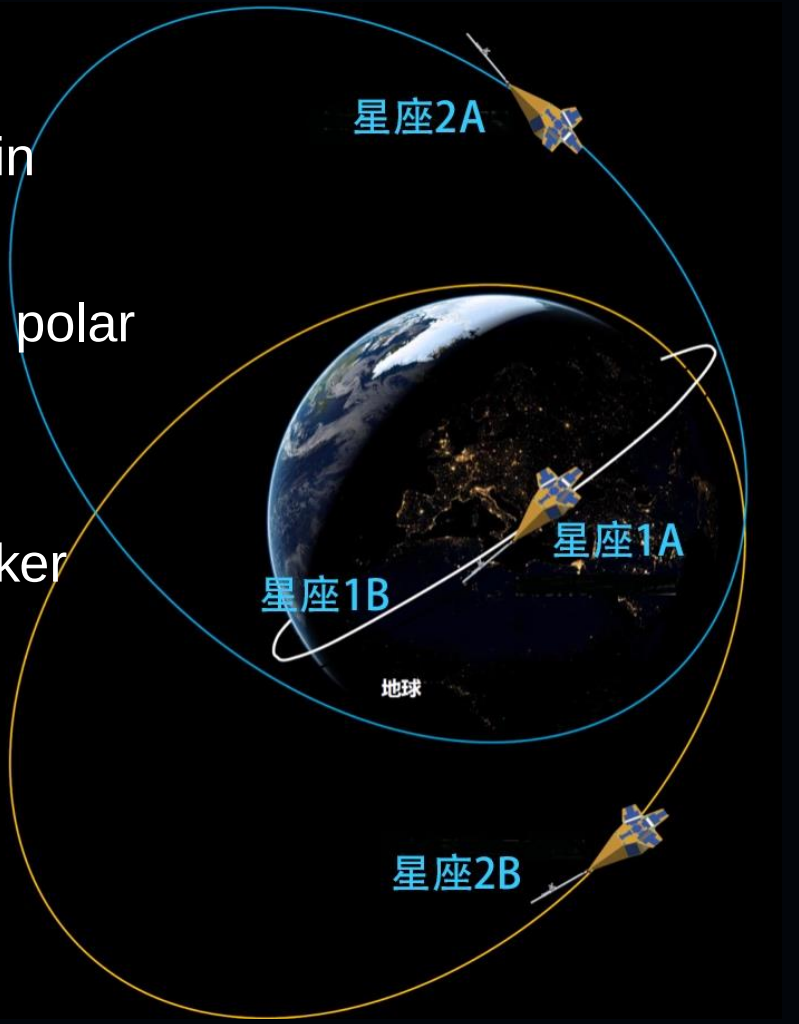
MSS-1: First Macau Science Satellite

- Launched on 21 May 2023
- 450 km altitude, 41° inclination
- Vector and scalar magnetometers, star tracker
- Operational since fall 2023, data available to all



MSS-2: Low altitude Second Satellite Pair

- In preparation for launch in 2026+
- < 200 x 1500 km elliptical polar orbit
- Vector and scalar magnetometers, star tracker



ESA EO has released a new Science Strategy

2024

The EO Science Strategy identifies four key strategic areas of action:

- **frontier science and discovery**
- **from science to societal benefits**
- **reducing critical knowledge gaps**
- **filling critical observation gaps**

ESA EO has released a

2024

ST-I Water Cycle	ST-II Carbon Cycle and Chemistry	ST-III Energy Fluxes	ST-IV Ecosystem Health	ST-V Extremes and Hazards	ST-VI Interfaces and Coupling
SQ05 Coastal sea level	**SQ01** Global carbon cycle	**SQ05** Drivers of coastal sea level changes	**SQ02** Land biosphere responses	**SQ36** Seismic deformation processes	**SQ07** Coastal process mediation of exchanges
SQ07 Coastal process mediation of exchanges	**SQ03** Ocean carbon cycle	**SQ20** Drivers of ice mass balance	**SQ03** Ocean carbon cycle	**SQ38** Earth's crust dynamics	**SQ24** Polar and high-mountain climate relationship
SQ20 Ice mass balance	**SQ08** Coastal carbon cycle	**SQ21** Drivers of sea-ice state and variability	**SQ08** Coastal carbon cycle	**SQ44** Water cycle	**SQ25** Polar Ecosystem Impacts
SQ21 Drivers of sea-ice state and variability	**SQ43** Coupled energy, water and carbon cycles	**SQ24** Polar and high-mountain climate relationship	**SQ25** Polar Ecosystem Impacts	**SQ51** Coupled litho-, atmo-, iono- and mesosphere	**SQ33** Solid Earth deformation
SQ25 Polar Ecosystem Impacts	**SQ52** Volcanic processes and their impact	**SQ35** Erosional processes of drainage basins	**SQ55** State of land ecosystems	**SQ52** Volcanic processes and their impact	**SQ35** Erosional processes of drainage basins
SQ33 Solid Earth deformation		**SQ43** Coupled energy, water and carbon cycles	**SQ56** Ecosystems transitions	**SQ56** Ecosystems transition	**SQ36** Seismic deformation processes
SQ43 Coupled cycles		**SQ45** Climate sensitivity			**SQ38** Earth's crust dynamics
SQ44 Water cycle		**SQ46** Earth energy imbalance			**SQ43** Coupled energy, water and carbon cycles
SQ45 Climate sensitivity		**SQ48** Planetary heat exchange			**SQ45** Climate sensitivity
		SQ51 Coupled litho-, atmo-, iono- and mesosphere			**SQ51** Coupled litho-, atmo-, iono- and mesosphere
		SQ52 Volcanic processes and their impact			

ESA EO has released a

2024

ST-I Water Cycle	ST-II Carbon Cycle and Chemistry	ST-III Energy Fluxes	ST-IV Ecosystem Health	ST-V Extremes and Hazards	ST-VI Interfaces and Coupling
SQ05 Coastal sea level	SQ01 Global carbon cycle	SQ05 Drivers of coastal sea level changes	SQ02 Land biosphere responses	SQ36 Seismic deformation processes	SQ07 Coastal process mediation of exchanges
SQ07 Coastal process mediation of exchanges	SQ03 Ocean carbon cycle	SQ20 Drivers of ice mass balance	SQ03 Ocean carbon cycle	SQ38 Earth's crust dynamics	SQ24 Polar and high-mountain climate relationship
SQ20 Ice mass balance	SQ08 Coastal carbon cycle	SQ21 Drivers of sea-ice state and variability	SQ08 Coastal carbon cycle	SQ44 Water cycle	SQ25 Polar Ecosystem Impacts
SQ21 Drivers of sea-ice state and variability	SQ43 Coupled energy, water and carbon cycles	SQ24 Polar and high-mountain climate relationship	SQ25 Polar Ecosystem Impacts	SQ51 Coupled litho-, atmo-, iono- and mesosphere	SQ33 Solid Earth deformation
SQ25 Polar Ecosystem Impacts	SQ52 Volcanic processes and their impact	SQ35 Erosional processes of drainage basins	SQ55 State of land ecosystems	SQ52 Volcanic processes and their impact	SQ35 Erosional processes of drainage basins
SQ33 Solid Earth deformation		SQ43 Coupled energy, water and carbon cycles	SQ56 Ecosystems transitions	SQ56 Ecosystems transition	SQ36 Seismic deformation processes
SQ43 Coupled cycles		SQ45 Climate sensitivity			SQ38 Earth's crust dynamics
SQ44 Water cycle		SQ46 Earth energy imbalance			SQ43 Coupled energy, water and carbon cycles
SQ45 Climate sensitivity		SQ48 Planetary heat exchange			SQ45 Climate sensitivity
		SQ51 Coupled litho-, atmo-, iono- and mesosphere			SQ51 Coupled litho-atmo-, iono- and mesosphere
		SQ52 Volcanic processes and their impact			

Living Planet Symposium 2025

Held every three years, ESA's Living Planet Symposia are among the **world's premier events on Earth observation**. The symposia continue to expand in both size and scope. With the climate crisis intensifying, the Living Planet Symposium 2025 (LPS25) emphasises transitioning from '**observation to climate action and sustainability for Earth**'.

The event provides a forum to present and discuss the *latest scientific findings and applications based on satellite data*, and to review the contribution that data and technologies have made and could further make in addressing *environmental and societal challenges*. The symposium will showcase innovative products, services, missions and initiatives, with the overarching goal of demonstrating how science, society, policy-making, businesses and the economy can all benefit from observations made from space.

During the five-day event, diverse communities united by a common interest in exploiting Earth observation data will gather, creating a unique opportunity to *meet and network with space enthusiasts from a wide range of sectors.*

Sessions of interest for the Heliophysics community:
A.01.02 Vertical Coupling in the Wole Atmosphere System
A.06.01 Geospace dynamics: modelling, coupling and Space Weather
A.06.02 Enhancing Space Weather Understanding: Insights from LEO Satellite-Based Operational and Pre-Operational Products
C.02.03 SMOS – 15 years in space
C.02.04 Small Earth Science Missions
C.02.06 Swarm - ESA's extremely versatile magnetic field and geospace explorer

23-27 June 2025, Vienna (Austria)

Living Planet Symposium 2025

Held every three years, ESA's Living Planet Symposia are among the **world's premier events on Earth observation**. The symposia continue to expand in both size and scope. With the climate crisis intensifying, the Living Planet Symposium 2025 (LPS25) emphasises transitioning from '**observation to climate action and sustainability for Earth**'.

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Sessions of interest f
A.01.02 Vertical Coup
A.06.01 Geospace dy
A.06.02 Enhancing Sp
C.02.03 SMOS – 15 ye
C.02.04 Small Earth Sc
C.02.06 Swarm - ESA's extremely versatile magnetic field and geospace explorer

Satellite-Based Operational and Pre-Operational Products

Abstract deadline 1. December!

https://lps25.esa.int /

23-27 June 2025, Vienna (Austria)

Thank you

https://earth.esa.int/eogateway

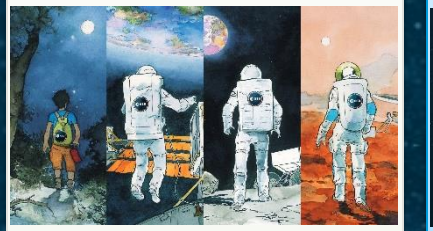
ESA Heliophysics

Update since last meeting - from Directorate of Technology, Engineering and Quality (D/TEC)

Piers Jiggens, TEC-EPS

ESA's Technology Programmes

Human & Robotic Exploration



ExPeRT (Exploration Preparation, Research and Technology)

Navigation

NAVISP (Navigation Innovation and Support Program)

Science

CTP (Core Technology Programme)

Space Transportation

FLPP (Future Space Transportation Ecosystem Programme)

Earth Observation

FutureEO (Future Earth Observation programme)

Telecomms

ARTES (Advanced Research in Telecommunications Systems)

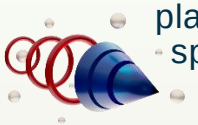
Technology (Generic) - https://technology.esa.int/

Programmes address different stages of development/maturity, measured by Technology Readiness Level (TRL) scale and each aims at increasing the TRL.

Open Space Innovation Platform (OSIP)

Open channels including **Discovery element** and Co-funded research https://ideas.esa.int

Technology Development Element (TDE)



Testing feasibility of prospective technologies allowing to plan and define future space missions and activities.

General Support Technology Programme (GSTP)

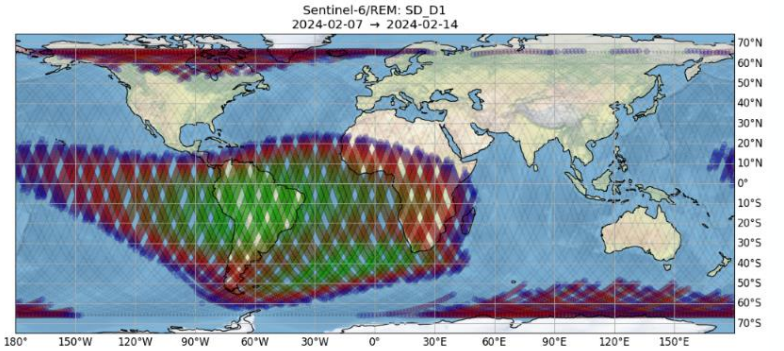
Evolves proven innovations into fully tested hardware ready for adoption by future missions.

Specification Modelling and Data Exploitation

TDE
CTP
ARTES

esa

- Environment modelling of radiation plasma, microparticle and atomic oxygen for mission specifications and requirements
- Notable Projects this year include:
  - GloRaB – Global Radiation Belt Prototype for LEO Constellations
  - VERSE - eVent-based Electron belt Radiation Storm Environments modelling
  - FIRESPELL - uniFied InteRplanEtary and Solar Particle Event modelling
- Focus here is on the near-Earth and interplanetary environments



ONERA
THE FRENCH AEROSPACE LAB

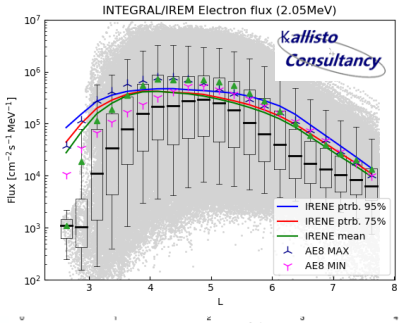
UCLouvain

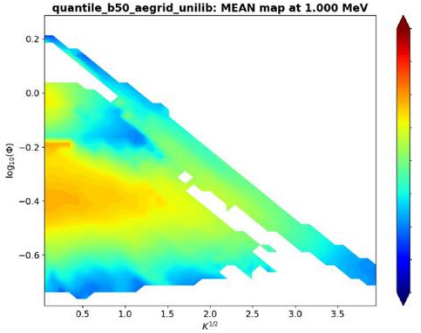
sparc

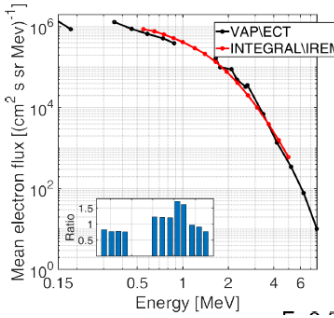
FINNISH METEOROLOGICAL

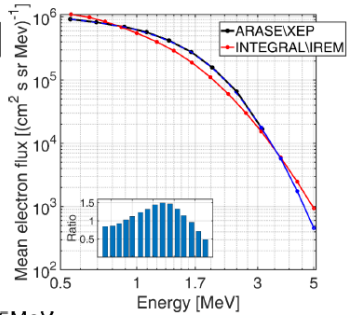
DH CONSULTANCY

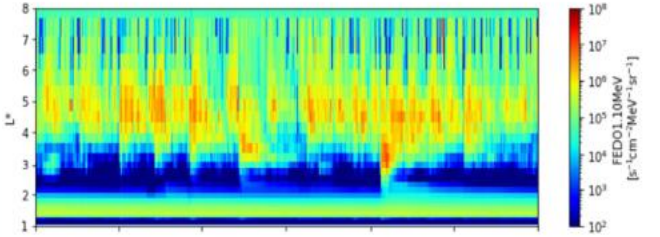
BIRA•IASB

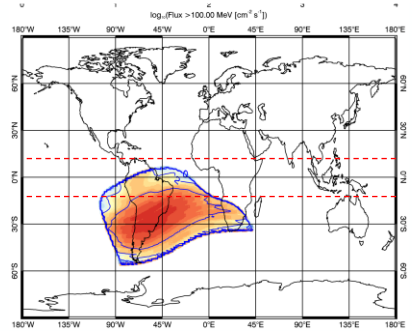


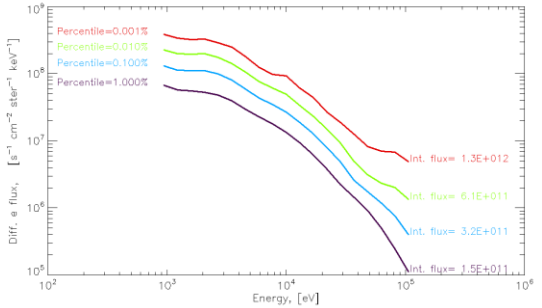


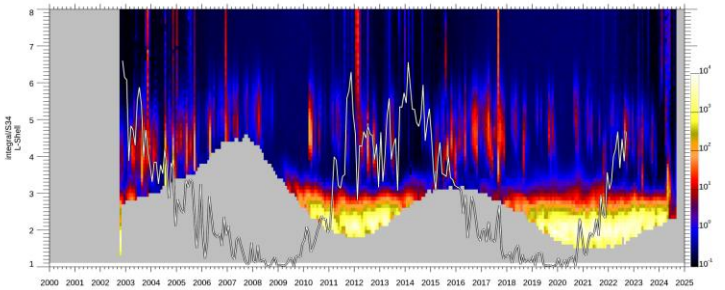


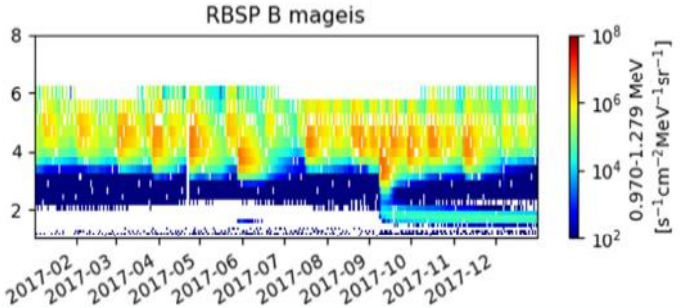












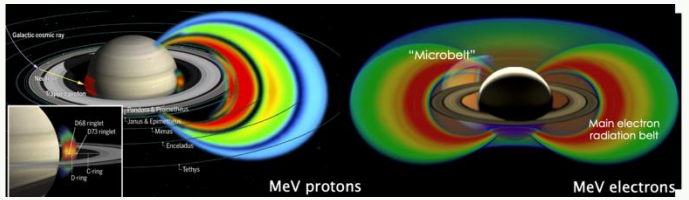
Planetary Env.and Space Weather Modelling

GSTP PRODEX S2P TDE esa

TRAPPED

ONERA THE FRENCH AEROSPACE LAB · irap astrophysique & planétologie · MPS

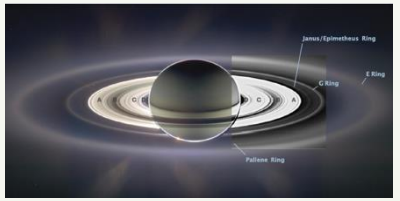
- Testbed for Radiation and Plasma Planetary Environments
- Modelling framework for radiation and plasma in gas giant magnetospheres
- Focus on Kronian system for future mission definition



Kronian system Environmental dust model

FREIE UNIVERSITÄT BERLIN

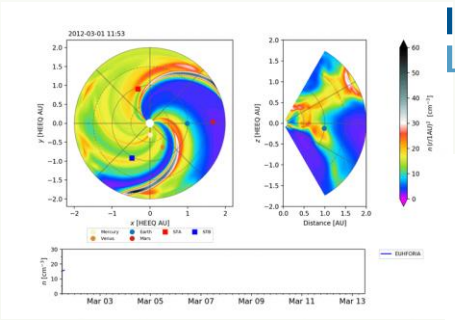
- Modelling hazard from (< cm) meteoroid environment in Saturn system to future space missions
- Uses plasma model from TRAPPED to simulate forces from charging and drag
- Includes dust emitted from the cryovolcanically active moon Enceladus



Space Weather Modelling

KU LEUVEN

- Virtual Space Weather Modelling Centre (VSWMC) is a central plank of future space weather modelling architecture
- Solar corona, solar wind, CMEs, solar particle radiation, radiation belts, magnetospheric plasma, plasmasphere, ionosphere interactions, thermosphere
- Complementary modelling activities

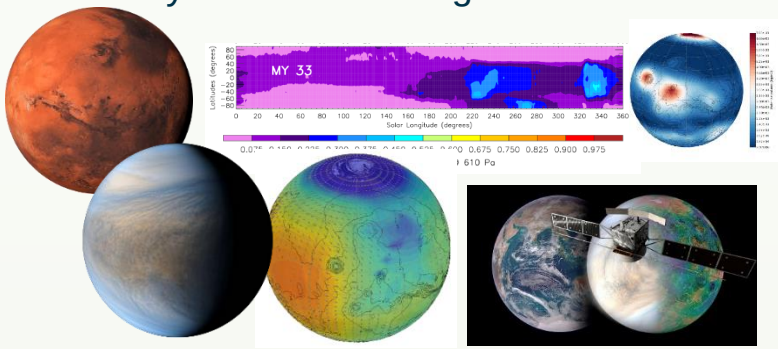


Imperial College London · Rays of Space

Mars Climate Database (MCD)

LMD

- Reliable models for Mars Climate.
- Altitudes from surface to exosphere,
- Atmospheric temperature, wind, pressure, composition, dust content…
- Use in EDL, mission design, data analysis and modelling of dust storms



Venus Climate Database (VCD)

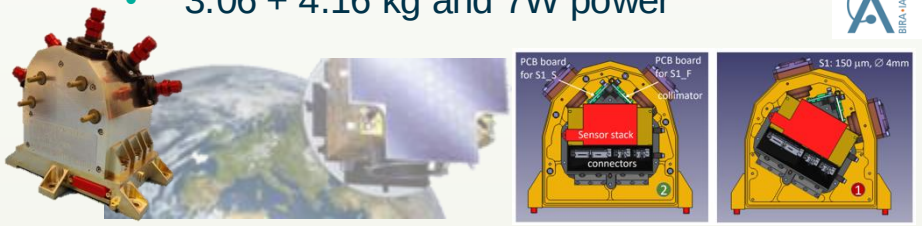
- VCDv2.3 meets similar objectives as the MCD but for Venus
- Focus on modelling density variability and associated uncertainties
- Current reference for EnVision mission design (e.g. aerobraking) and planning

Environment/Science/Helio Instrumentation

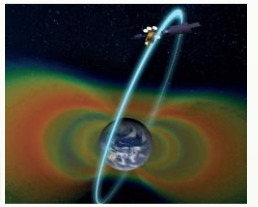
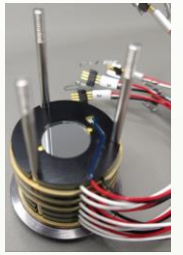
GSTP
S2P
PRODEX

3D-EES: 3D Energetic Electron Spectrometer

- Proba-3 orbital period is 19.7 hours
- e- [0.1 - 10 MeV] and p+ [4 - 50 MeV]
- 3x2 orthogonal sensor modules each sensor with a field-of-view of 14.25°
  - 3.06 + 4.16 kg and 7W power



NORM: Norwegian Radiation Monitor

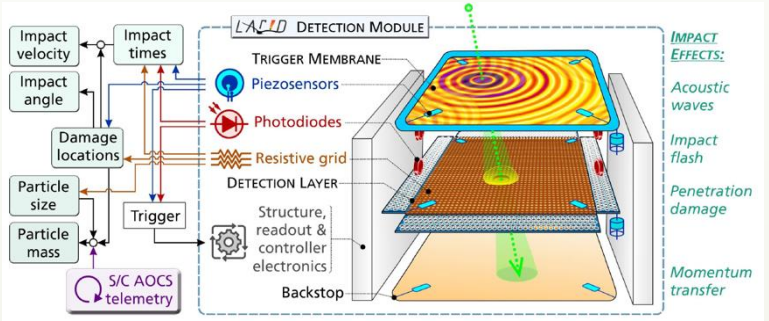
- Arctic Satellite Broadband Mission (ASBM)
- Launched Aug. 2024. 43000 x 8100 km (63.4°)
- Collimated stack of Si diodes and absorbers.
- Measures e- [0.5 - 7 MeV] and p+ [7 - 200 MeV]
- 2.9 kg – 3 W - 2.1L (detector and data handling)

ESWEP-DAF

- Breadboarding activity
- Lunar surface package
- To include:
  - Electric Field
  - Dust
  - Langmuir Probes
- TRL 4 by end 2025

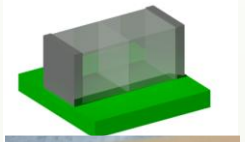
Large area low resource integrated impact detector

- 1-10 m^2 with < 5 kg/m^2 10 W/m^2
- LEO, GEO & interplanetary missions
- Particles >0.1-10 mm and 5-30 km/s



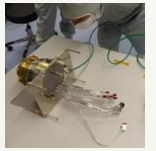
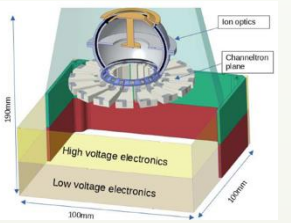
HEPI: High-Energy Proton Instrument

- Cherenkov detector
- 2 radiators and SiPMs
- Target 1U and < 1 kg
- >300 MeV protons
- Geant4 simulations
- Beam testing at TRIUMF (Canada)
- Human spaceflight and aviation applications




Plasma Monitor (PLASMON)

- Electrons and ions
- 10 eV to 30 keV
- 8-80° polar (5° resolution)
- 30° azimuth (22.5° resolution)
- Heritage: Juice/JEI
- 4s/1s (2d spectrum)
- 2 kg

TEC Missions and Instruments - Relevant Updates

HEliospheric pioNeer for sOlar and interplanetary threats defeNce (HENON)

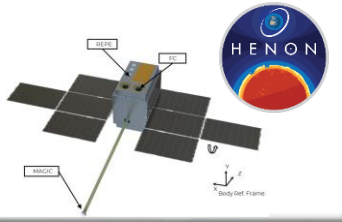
Launch:
December 2026

Orbit:
Distant Retrograde Orbit (DRO)

Platform: 12U XL CubeSat

Payload:
Relativistic Particle Instrument
Magnetometer
Faraday Cup

Status:
Phase C1



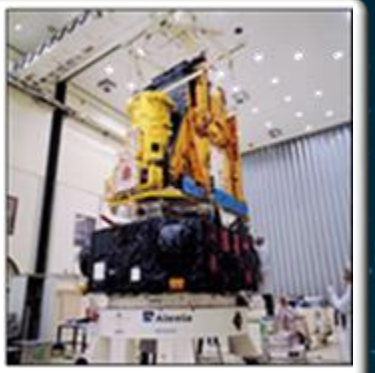
Integral/IREM (D/SCI)

Launch: 2022

Orbit: Highly elliptical (3-day)

Instruments: (beyond photons)
IREM (Integral Radiation Environment Monitor)

Updates:
Mission science to end in Q2 2025.
IREM operations until re-entry in 2028



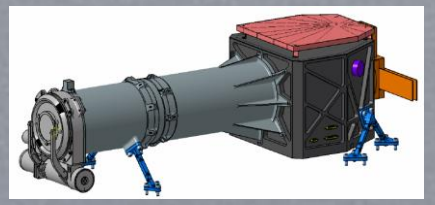
PROBA-3

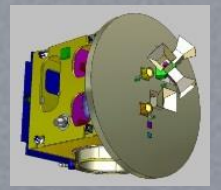
Launch:
Dec 2024 (PSLV)
Formation Flying Mission

Orbit:
600 x 60530 km at ~59° inclination
2 satellites with intersatellite links
Position Precision: ~ 1 mm

Lifetime:
2-4 years
Distance, resizing : 25 – 250 m
Attitude Precision: ~10 arcsec

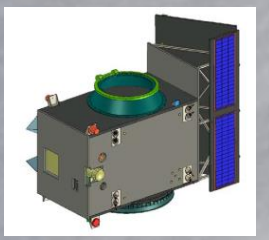
Occulter Spacecraft:
200 kg, 120 Mb/orbit, 50 m/s





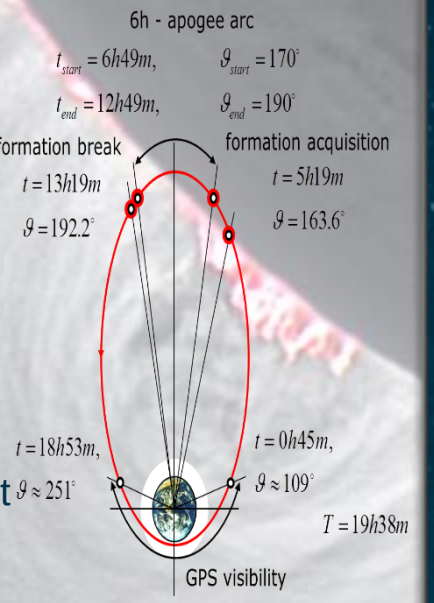
Payload:
Coronagraph, ~150 m, 1.08 R_{Sun},
Radiometer, 3D-EES (radiation)

Coronagraph Spacecraft:
340 kg, 280 W,
9 Gb/orbit, 125 m/s



Coronagraph planning, commanding, calibration, and dissemination to scientists

TM data to experiment providers and SOC, Verification benches

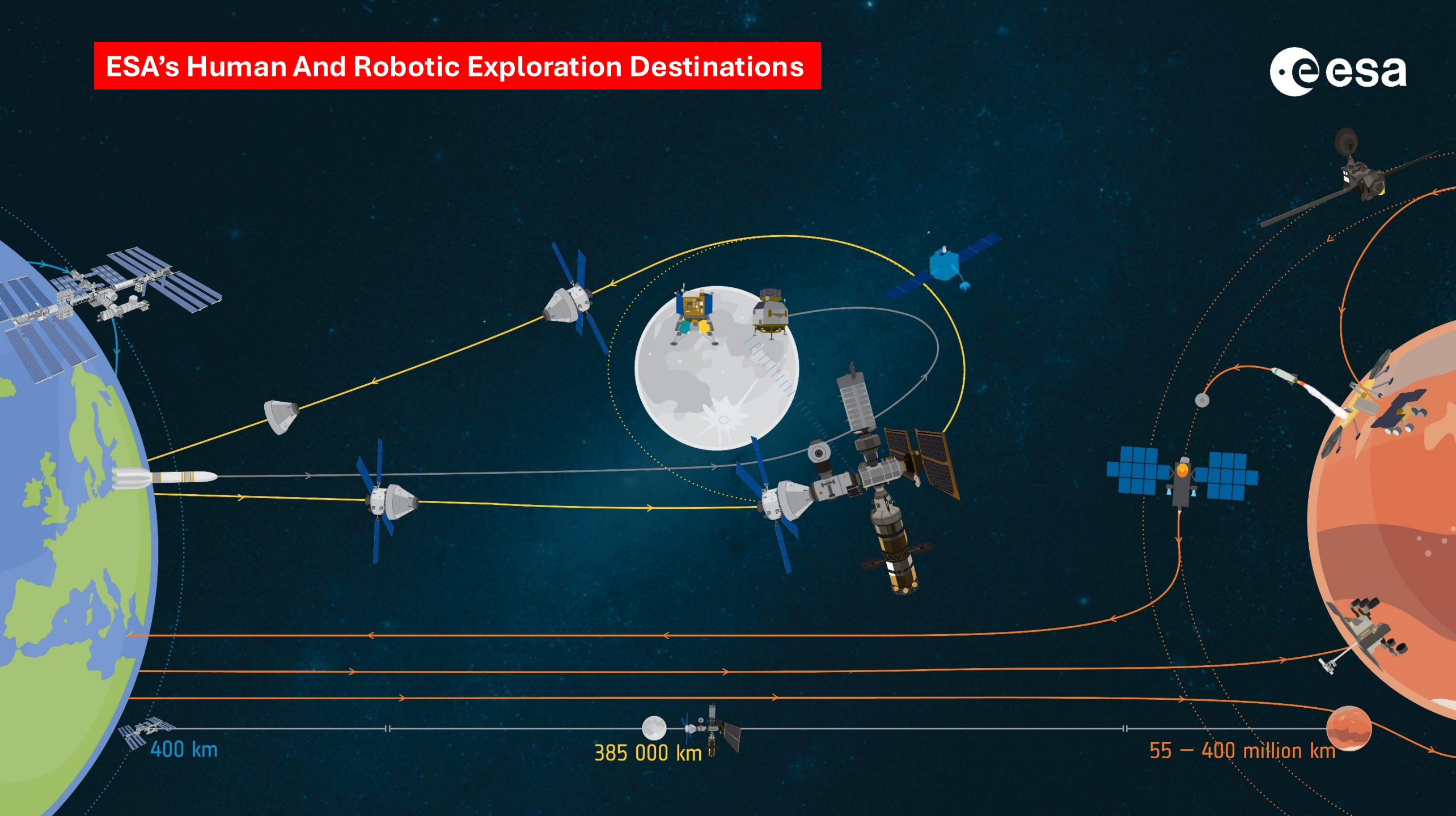


ESA Heliophysics

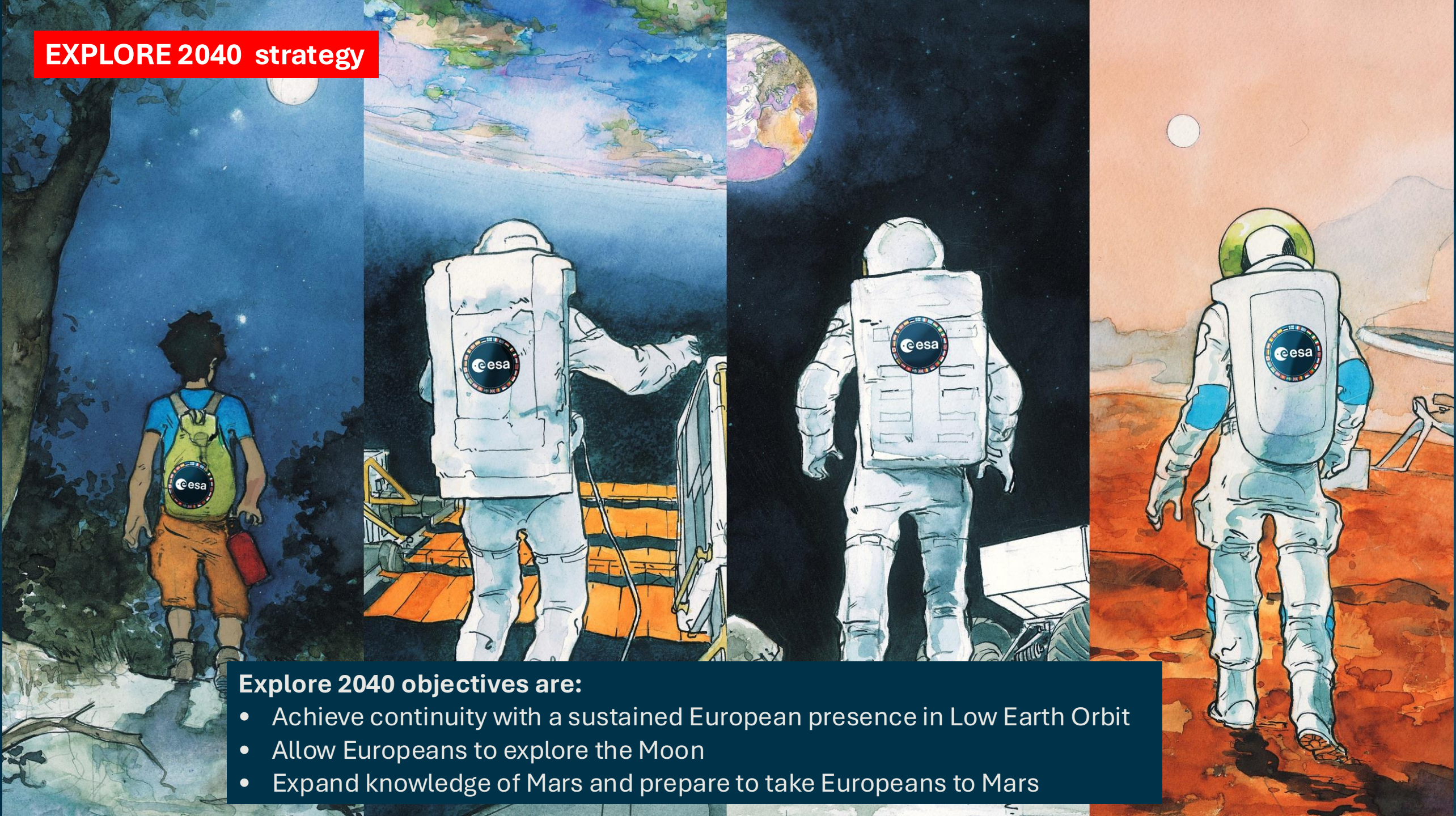
Update since last meeting - from Directorate of Human and Robotic Exploration (D/HRE)

James Carpenter, Francesca McDonald (HRE-LS), Sebastien Vincent-Bonnieu (HRE-SU),
Piers Jiggens, Giovanni Santin (TEC-EPS)
Heliophysics in Europe, 30/11/2024

ESA’s Human And Robotic Exploration Destinations



EXPLORE 2040 strategy

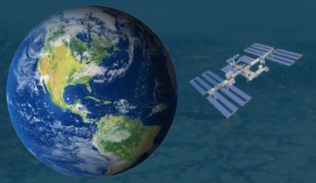


Explore 2040 objectives are:

- Achieve continuity with a sustained European presence in Low Earth Orbit
- Allow Europeans to explore the Moon
- Expand knowledge of Mars and prepare to take Europeans to Mars

DESTINATIONS vs. CROSS-CUTTING THEMES

Facilities on Earth and Suborbital Platforms



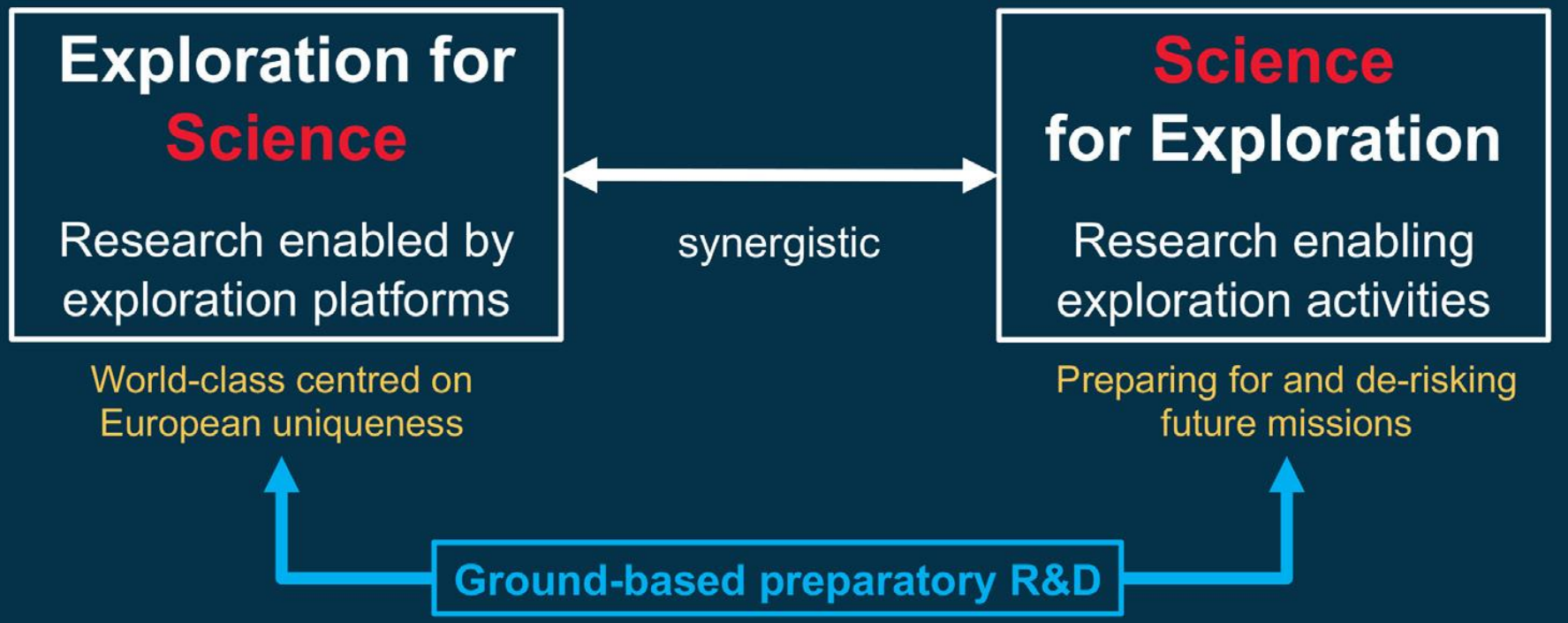
Low Earth Orbit

Moon and Lunar Orbit

Mars and Mars Orbit

Human Exploration

ESA EXPLORATION SCIENCE: TWO STREAMS



Key cross-cutting fundamental and applied research topics, with down to Earth applications

ENABLED SCIENCE and EXPLORATION SCIENCE

Enabled science

A: Fundamental physics and astrophysics	
B: Material sciences	
C: Fluids sciences, soft matter and biophysics	
D: Space and planetary environments	
E: Biology	*Fundamental Biology*
	Space Biotechnology and Agriculture
	Astrobiology
F: Human Physiology	
G: Planetary Science	

Exploration science

Local Resources

Environments and Effects

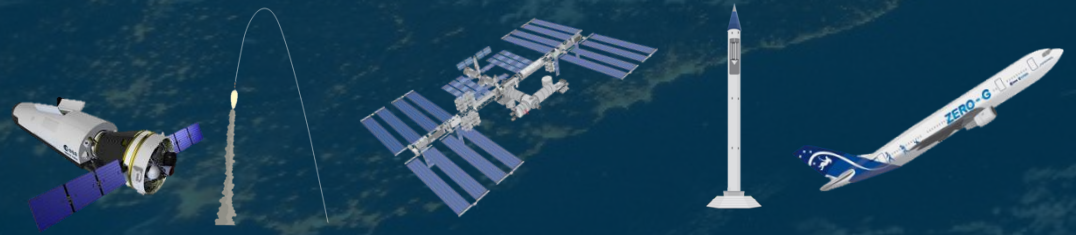
Crew Health and Performance

Habitation

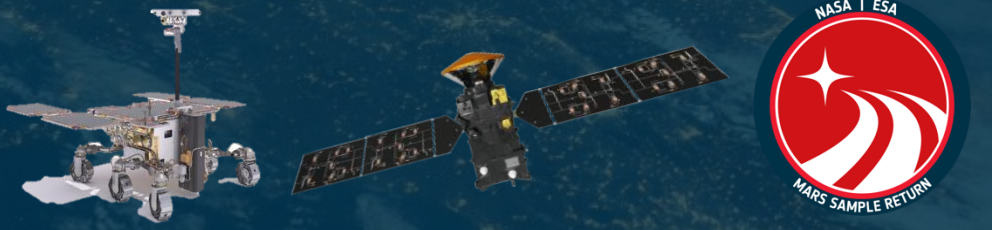
ESA HRE EXPLORATION SCIENCE PROGRAMME - PLATFORMS

GROUND PLATFORMS

MOON



LOW GRAVITY PLATFORMS



MARS

Ground based facility

ESA identified **5 European accelerator facilities** to provide beam-time necessary to conduct experiments:

- GANIL facility, Caen, France (Cyclotron)
- AGOR KVI-CART, Groningen, The Netherlands (Cyclotron)
- HIT, Heidelberg, Germany (Synchrotron)
- UPTD, Dresden, Germany (Cyclotron)
- Trento Proton Therapy Center – TIFPA, Trento, Italy (Cyclotron)

Proposals can be submitted in the IBPER call on OSIP platform

ESA-FAIR Space Radiation School at GSI Helmholtzzentrum für Schwerionenforschung GmbHin Darmstadt:

- Target audience for students
- application around February

Solar and high energy experiment onboard the ISS

ESA's Solar facility on the Columbus module have been studying the Sun's irradiation with extreme accuracy across most of its spectral range in 2008 – now decommissioned.

SOLAR (ESA)

CODEX (NASA)

Other instruments:

- Alpha Magnetic Spectrometer (NASA)
- Coronal Diagnostic Experiment-CODEX (NASA)
- CALorimetric Electron Telescope (JAXA)
- BTN-Neutron-Radiation-ISS (Roscomos)

AMS (NASA)

Science and technology on the Moon

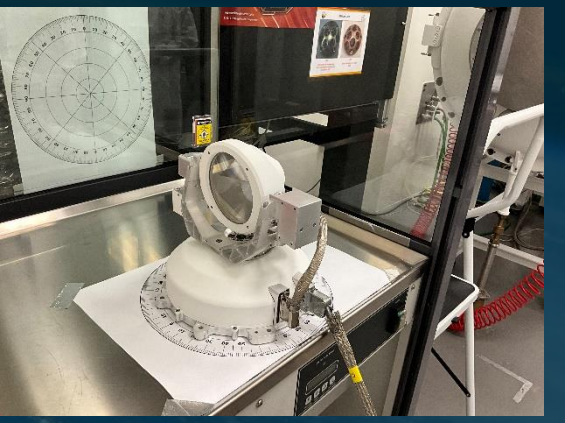
◄ Lunar environment

Negative Ions at the Lunar Surface (NILS) Flew to the Moon with the Chinese Chang'e 6 mission examining the interaction of the solar wind with airless bodies

- Landing on 1 June 2024
- NILS was operated for around 3.5 hours

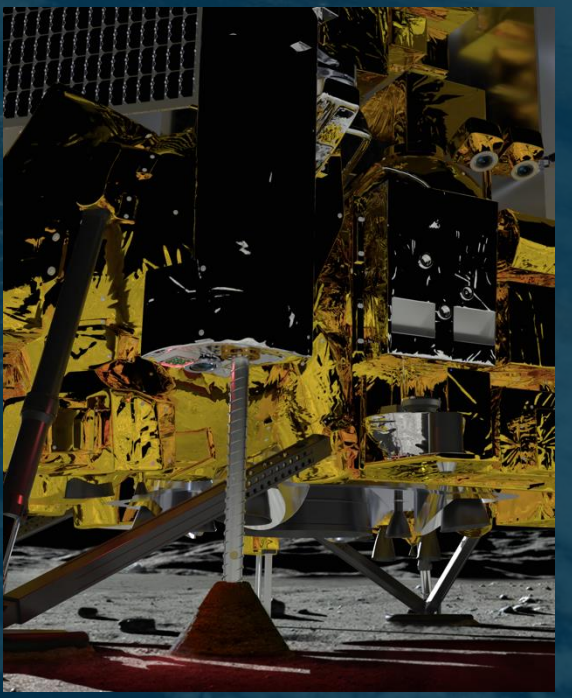
Geophysics ►

MoonLIGHT laser retroreflector on Intuitive Machines mission IM3, ranging from Earth to probe the interior of the Moon and relativistic physics



Resources characterisation ►

PROSPECT drill and chemical laboratory: drilling at the lunar South Pole for ice and volatile chemistry. Resource utilisation experiment

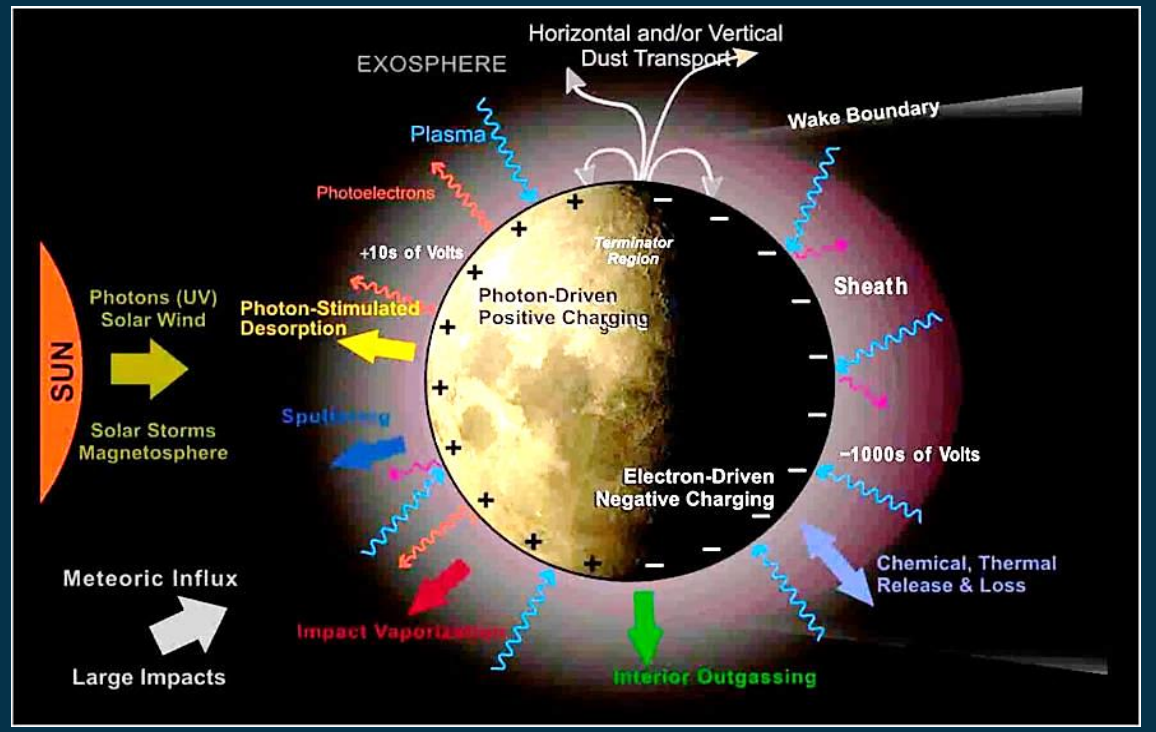


Future prospects: Exploration driven activities, environment monitoring, resources characterisation, sample selection and return, space biology, human health research, physics and astrophysics (longer term)

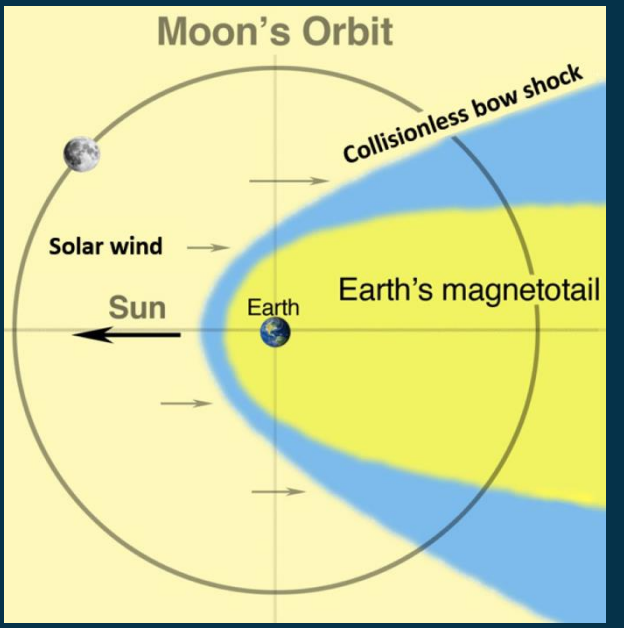
Lunar Surface Environment Investigation Themes

Interrelated **investigation themes** have been identified, including:

- Plasma particles and fields
- Energetic particles environment
- Dust environment
- Earth magnetospheric environments
- Surface-bounded exosphere
- Human exploration impact



Dandouras et al, 2023, after Halekas



Adapted from: Tim Stubbs/University of Maryland/GSFC

AstroLEAP Science Traceability and Definition

- An international Facility Definition Team (FDT) of space environments experts has supported ESA in preparing a **Science Definition Report** and **Science Traceability Matrices** for informing AstroLEAP preparation.

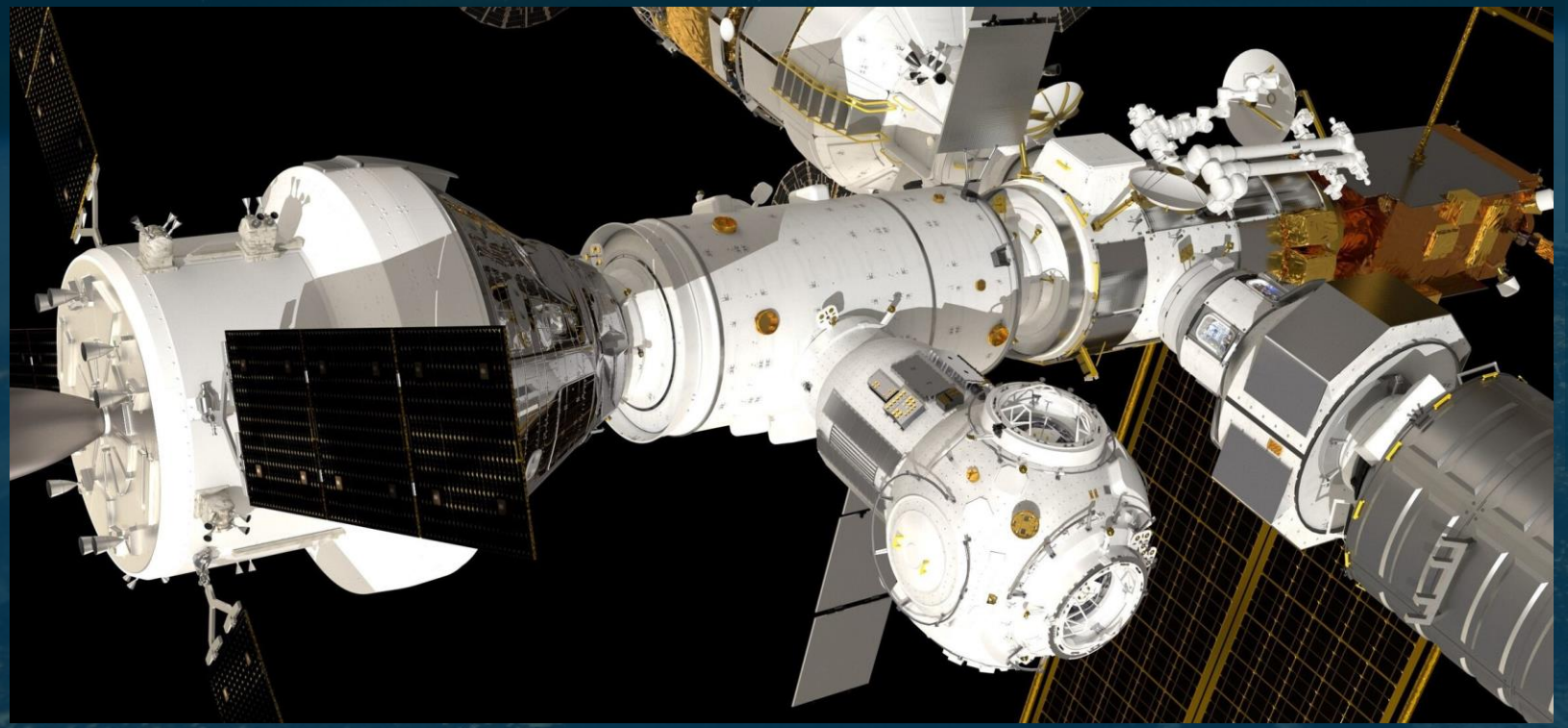
International Agency Objectives

AstroLEAP Facility Definition Team: International team of science experts and ESA exploration environment models experts

Science Definition and Traceability:

- Exploration science questions and challenges
- Investigation themes
- Measurements definition
- Example analytical approaches and heritage
- Payload deployment and functional requirements

Radiation monitoring on Gateway



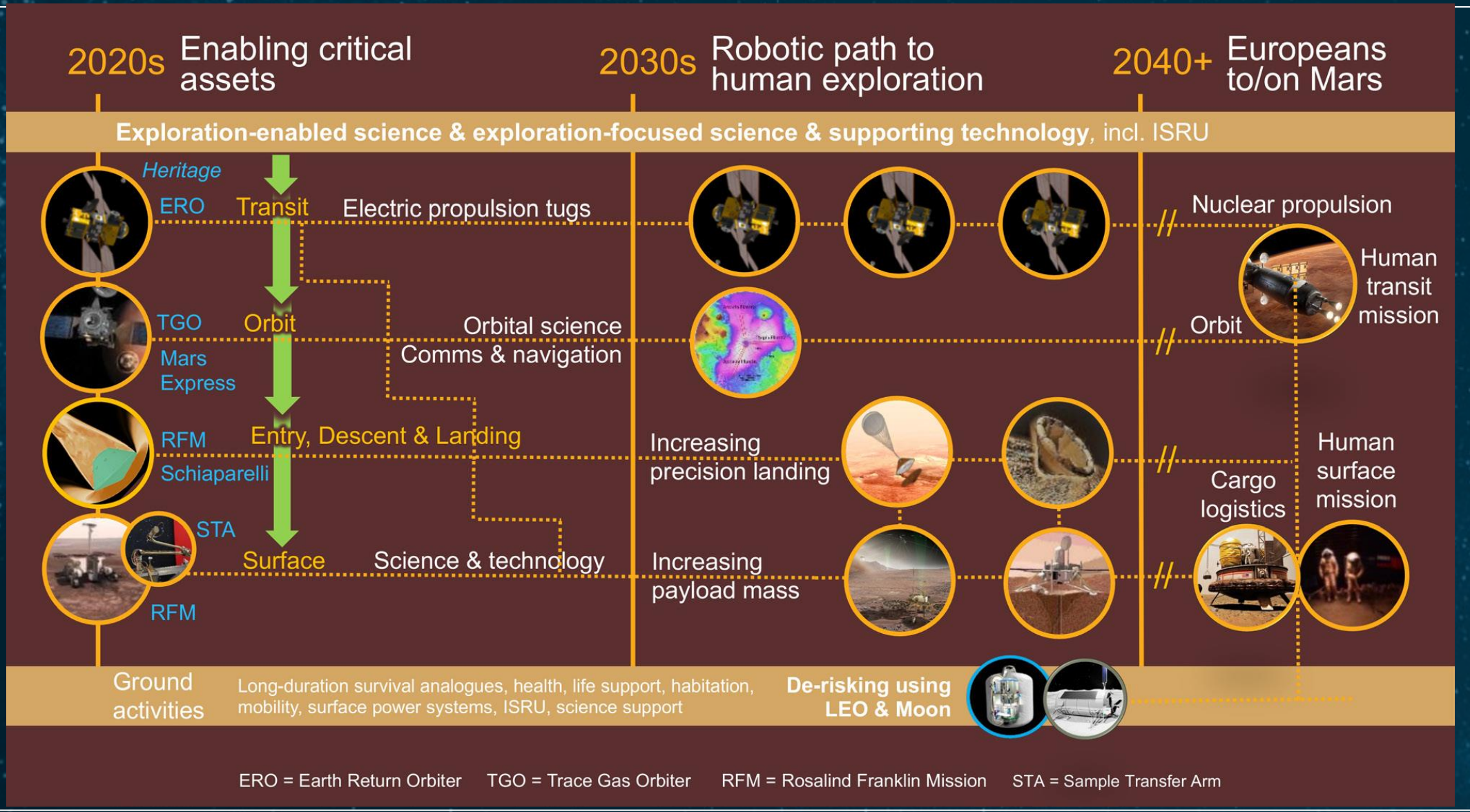
◄ Radiation European Radiation Sensor Array (ERSA) – External deep space radiation environment and space weather

◄ Radiation Internal Dosimeter Array (IDA) – Internal radiation as experienced by crew

Future prospects :

Active Sensors for Telemetry of Extraterrestrial Impactors At Gateway (ASTERIA) is a package of instrumentation which aims to characterise and monitor the environment at Gateway. Dust telescope as a core instrument.

Explore2040 @Mars



FROM SCIENCE TO MISSION

Access to the destinations

Spacecraft/Payload Development

Systematic build-up of knowledge with each cycle

Data Archiving

Announcement of Opportunity

https://ideas.esa.int

Exploration Science Goals driving Payload and Mission Design

Mission/Payload Studies

Data Analysis, Research

Open and Planned Research Announcements

Ground and Sub-Orbital Platforms

Parabolic Flight (2 to 3 campaigns per year)	continuously open
Drop Tower (120 drops/annually)	continuously open
Ground-based facilities, incl. radiation via IBPER	continuously open
FLY! AO	open until 15 January 2025
IBPER Radiation AO for beamtime at GSI	planned to open Q4-2024/Q1-2025
Tissue chips and organoids AO	open until 31st Jan 2025
Sounding rocket AO	planned to open Q4-2024/Q1-2025
TEMPUS electromagnetic levitator AO	Q4-2025

ISS

Transparent Alloy AO	Q3-2024

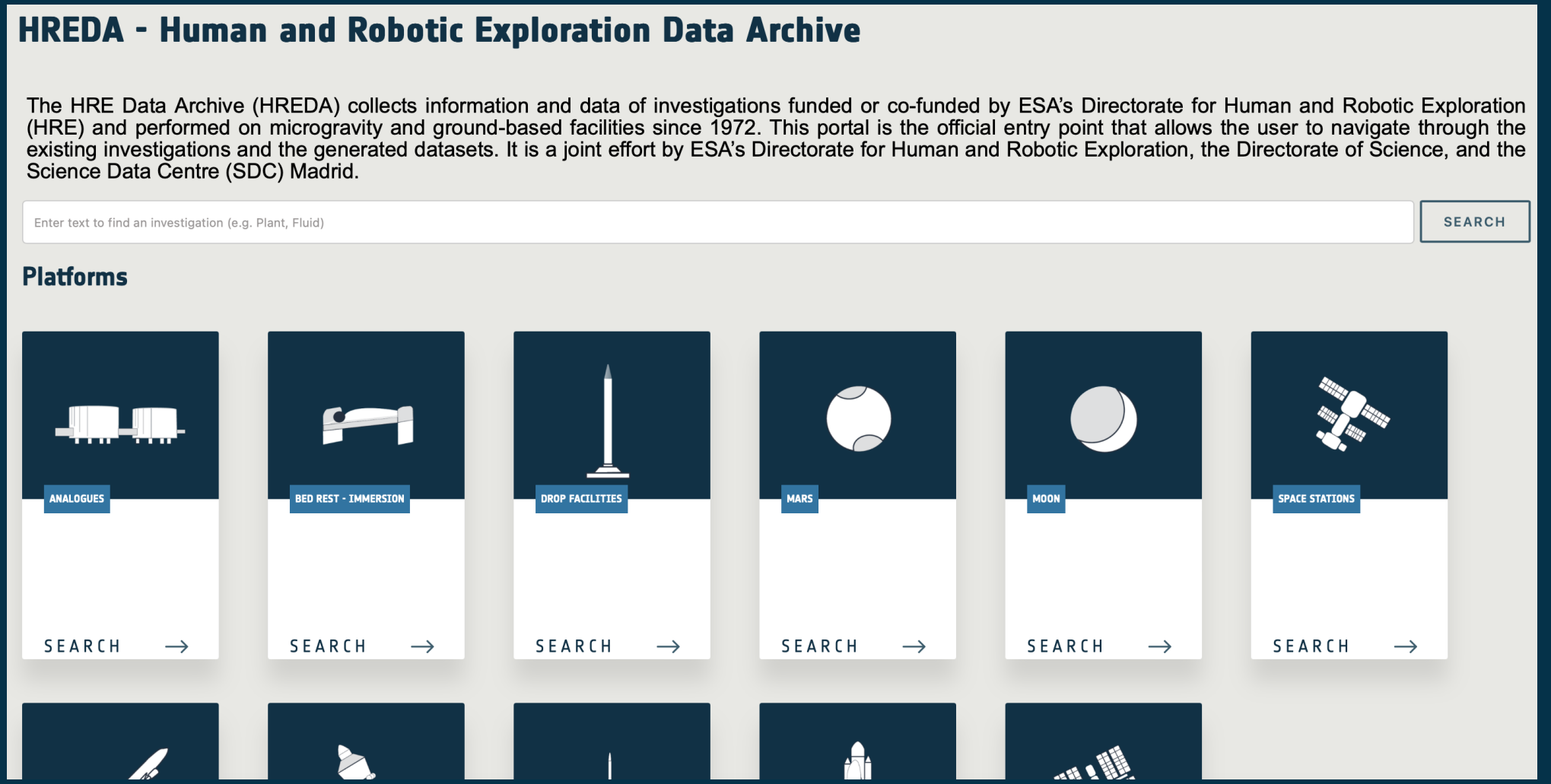
Gateway

RFI for human research at Gateway	Open until 25 November 2024

Application online via the platform https://ideas.esa.int/

HRE DATA ARCHIVE

https://hreda.esac.esa.int/



THANK YOU!

https://scispace.esa.int [sign up for the newsletter]

ESA Heliophysics WG

– recap from last years meeting

Heliophysics in Europe meeting 2023

30 October – 3 November 2023 at ESA ESTEC, 260 registrations 93 abstracts, 140 in person + 90 online

Hosted by the ESA Heliophysics Working Group, who represent Heliophysics related activities across 5 different directorates in ESA. The ESA HWG presented these activities to the attendees.

The community component was organised overall with the general topic

Building Bridges in Heliophysics: open questions, missing observations, measurements, models, and investigative techniques

and the following subtopics, and community building sessions

Topic 1: Interdisciplinary science targets , Topic 2: Mission Concepts, Topic 3: Multi-Instrument and general Science, Topic 4: Data, analysis methods, instruments

Building a European Heliophysics network and community hub

Workshop Reporting, Summary, SWOT discussion and next steps

Information still available on web site

https://www.cosmos.esa.int/web/esa-heliophysics/heliophysics-in-europe-2023

Recommendations to Community from Attendees

1. The attendees observed that deciding on a single term to describe the community is challenging, but that the “European Heliophysics Community” was a good umbrella term, if well defined. **The attendees recommend that they should construct an agreed list of keywords describing fields to define this umbrella term e.g. Solar remote sensing, ionosphere, magnetosphere etc. which can be expanded.**

2. The meeting attendees observed and acknowledged that this somewhat experimental workshop was very successful in bringing together a remarkably diverse range of the community and providing valuable insights into the broad heliophysics-related activities across ESA. **The attendees recommend that such an activity is repeated, to build up the community, identify more synergies and improve communication across the community - potentially this next meeting could be named the “The 1st European Heliophysics Community workshop” to highlight and celebrate the ‘birth’ of the broad community. Session 4 material would form specific topics for discussion at that meeting.**

3. The attendees observed that a splinter meeting at EGU should be organised to take stock of the progress of these actions. **The attendees recommend that a yearly dedicated EGU splinter session be organised to discuss ongoing EHC related activities.**

4. The attendees noted that a number of email lists exist to communicate to the community. The European Heliophysics Community newsletter was identified as a good location to act as an information conduit. The attendees recommend that the community sign up to the EHC newsletter*. **The meeting attendees also recommend that there should also be a list of existing email lists drawn up from both community and ESA email lists via which the EHC should be advertised.**

5. The attendees observed that not all disciplines or career stages were represented. **The attendees recommend that the word is spread on connecting more people to this activity and community, using the lists in point 4.**

6. The attendees observed the need for a training programme or mentoring for Early Career Researchers (ECR), for future missions, as well as access/information to new activities in ESA programs. ECR is considered here to be 7 years from PhD or beginning of research in a certain topic. **The attendees recommend that interested ECRs join the ECR corner in Zulip to discuss further steps on organisation of the ECR community.**

7. The meeting attendees observed that unique keywords could be a rapid way to create community identity **The attendees recommend that ORCID keyword “EHC” is proposed for the community to start using.**

8. The meeting attendees observed the utility of Zulip for communicating in a more rapid, ad-hoc, informal manner. **The attendees recommend the continued use of Zulip** as a community communication and chat device.**

9. The attendees raised the idea of a community roadmap. **The attendees recommend that such a topic should be the focus of a dedicated session at a future meeting, such as the 1st EHC Community workshop , mentioned in point 2 above.**

*https://www.cosmos.esa.int/web/esa-heliophysics/european-community

**https://euro-helio.zulipchat.com/

Recommendations to ESA from Attendees

1. The attendees observed that the newly-formed ESA Heliophysics Working Group (HWG) is an excellent start to bringing cross-directorate collaboration on Heliophysics. **The attendees commend this activity and recommend that it should continue.**

2. The attendees observed that the ESA HWG has successfully established connections between various directorates within ESA. **The attendees recommend and urge the ESA HWG to ensure that it includes all entities in the ESA whose activities are relevant to Heliophysics.**

3. The meeting attendees observed and acknowledged that this somewhat experimental workshop was very successful in bringing together a remarkably diverse range of the community and providing valuable insights into the broad heliophysics-related activities across ESA. T**he attendees recommend that the workshop should be repeated to foster more synergies and facilitate communication across the community and to the different ESA directorates. A workshop should be held next year, and at a TBD cadence after that. Potentially this 2024 meeting could be a combined ESA HWG meeting and "The 1st European Heliophysics Community workshop" to highlight and celebrate the 'birth' of the broad community.**

4. The meeting attendees observed that some aspects of the hybrid meeting worked, with good poster availability and Zulip chat, but that the engagement online could be improved by having more dedicated people online. This is not a criticism of those who did a sterling effort online, but that this could be enhanced with more support. **The meeting attendees recommend that future meetings should have several dedicated online conveners.**

5. The meeting attendees observed the strength of combining ground and space-based facilities as well as modelling. **The meeting attendees recommend that ESA HWG investigate more formal collaboration and coordination between its activities and ground-based facilities and modelling.**

6. The meeting attendees observed the good progress in a variety of data processing, archiving and visualisation and analysis activities. However, sometimes these are challenging to find or even know about. **The meeting attendees recommend that ESA HWG work towards improving data accessibility and discoverability (e.g. lists of useful data and archive links) of all missions and facilities relevant to Heliophysics.**

7. The meeting attendees observed that the presented programs were quite complex and used similar terminologies for activities that were completely different.. **The meeting attendees recommend that the ESA HWG provide a comprehensive guide that covers all relevant ESA activities related to Heliophysics (overall structure, types of missions, etc).**

PENDING ACTIVITY – this overview presentation will be made availible however as an interim solution

The ESA Heliophysics WG are re-visiting their terms of reference and will discuss if anything needs changing.

Part of the discussion last year was about connection/communication. Although not a formal recommendation, a place to try and find people was thought to be useful.
To address this, the ESA HWG have set up the capability for a community database, available at the ESA Helio web pages!

Will open it shortly after workshop.

SUBSCRIBE TO THE EUROPEAN HELIOPHYSICS COMMUNITY DIRECTORY

WHAT IS THE EHC DIRECTORY?

The aim of the EHC is to provice a quick access to European Heliophysics Community colleagues, in terms of name, Institute and interests. This allows colleagues to contact one another for collaborations etc.

PREREQUISITES

1. The EHC Directory is for Heliophysics space scientists in Europe or interested in European Heliophysics to connect with one another
2. EHC Directory subscriptions must accepting the code of conduct and the member privacy notice
3. EHC Directory subscription requires a Cosmos account

If no other content appears below this line, please log into Cosmos using the **Sign In** option at the top-right of the portal.

If you don't have a ESA Heliophyiscs account/Cosmos account, please follow the Self-Registration process here:

ESA Heliophysics registration

CONSENT REQUIRED FOR SUBSCRIPTION

Subscription to EHC Directory requires consent to the following :

1. ESA Directorate of Science Code of Conduct
2. ESA EHC Privacy Notice

The privacy notice includes consent for your details to be published on the ESA Heliophysics web pages which is accessible to those registered to the Cosmos ESA Heliophysic web pages. This is required to fulfill your obligation to be reachable by collaborators from other institutions and consists of participation in a membership list containing name, ORCID ID, institute, research interests and contact details via a (capcha-protected) form. When subscribing to the EHC Directory using the form below, please include a list of no more than 30 keywords/phrases describing your research interests.

Please note that all subscription requests will be modereated by the ESA Heliophysics webmaster before acceptance.

European Heliophysics Community Directory Subscription

Please complete this form to subscribe your details for the European Heliophysics Community Directory.
The aim is to provide a location for other registered colleagues to find similar interests/specialities and encourage collaboration and communication.
Email addresses are visible, but ONLY for those registered within this ESA Heliophysics page (so not public).

The processing of personal data is described in the privacy notice, which you may your consent to by accepting this privacy notice (selecting the 'I accept' checkbox) prior to submitting the registration form.

By registering, I accept and consent to:

Allowing the publication of my name, pronouns, institute/organisation, ORCID iD, professional interests, and email address in the European Heliophysics Co mmunity Directory by ESA to members of the international Science Community registered at the ESA Heliophysics web page and subscribed to the Europe an Heliophysics Community Directory.

I understand that the publication of my personal information address carries risk in that it can be used for purposes other than intended by the publication a nd may lead to unwanted effects such as receiving of spam email, facilitation of phishing attempts as well as increased risk of identity theft.

Name

Pronouns (optional)

ORCID ID

Institution / location

Brief research interest (<30 keywords/phrases)

Email

☐ **I accept and consent to the ESA EHC privacy notice (available above)**

Send

ESA PRIVACY NOTICE FOR The European Heliophysics Community Directory

Released by: European Space Agency, as Data Controller

Addressed to individuals whose personal data are collected and processed

Concerning collection and processing initiated by: **ESA SCI-E Department (hereinafter referred to as the "Department")**

The European Space Agency (hereafter "the **Agency**" or **"ESA"** or **"We"**) is committed to protecting Personal Data in line with the ESA Framework on Personal Data Protection (herein the **"ESA PDP Framework"**) available at: http://www.esa.int/About_Us/Law_at_ESA/Highlights_of_ESA_rules_and_regulations composed of:

- the Principles of Personal Data Protection adopted by ESA Council on 13 June 2017
- the Rules of Procedure for the Data Protection Supervisory Authority adopted by ESA Council on 13 June 2017
- the Policy on Personal Data Protection (including its Annex entitled "Governance Scheme of the ESA's Personal Data Protection") adopted by the Director General of ESA on 1 March 2022 ("**ESA PDP Policy**").

This notice is intended to describe why and how Your personal data are collected and processed by or on behalf of ESA as Data Controller, on the initiative of the ESA above-mentioned Department, as well as what rights You have in relation to Your personal data. It also informs You about the contact details of the Data Protection Officer. This privacy notice was last updated on 22-07-2024. It must be read in conjunction with the ESA PDP Framework and other privacy notices referred to herein.
/07/2024

(1) ***How can you contact ESA regarding this notice?***

The ESA Data Protection Officer ("DPO") may be contacted in line with the ESA PDP Framework at DPO@esa.int. Specific information is available upon request from the DPO.

SEPARATE CONTROLLERS:
To know the point of contact for personal data protection matters concerning separate Controllers (which are independently responsible for the collection and processing of personal data they decide upon), please refer to the privacy notices of these separate Controllers. Your queries regarding these matters will not be dealt with by ESA or its DPO.

(2) ***What kinds of personal data are collected and further processed?***

We collect and process various kinds of personal data and may require You to provide personal data for the purposes mentioned later in this notice. Depending on the purpose for which they are collected and further processed, the personal data may include the following:

- **Identity Data**: including Your names, pronouns
- **Professional information**: including email address, Institute/Organisation, ORCID iD
- **Professional career data**: including Your areas of interest in Heliophysics;
- **Other data, such as:**
  - Your messages/correspondence, date, and time the message was sent;
  - the content of any questions you have asked;
  - other data mentioned in Your messages;

(3) ***How are Your personal data collected or further processed?***

EUROPEAN HELIOPHYSICS COMMUNITY DIRECTORY

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

Name	Institute	ORCID ID	Research interests	email address
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S				
T Matt Taylor	ESA, ESTEC, Netherlands	0000-0002-4206-0250	Magnetosphere, Kelvin Helmholtz waves, plasma boundaries, energetic particles	Matthew.Taylor@esa.int
U				
V				
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Y				
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Thank you for your attention!

Questions?