The ESA Heliophysics Working Group:

28/10/2022

ESA Heliophysics Working Group –

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ESA Heliophysics Working Group: Background

Heliophysics, ***the science of understanding the Sun and its interaction with the Earth and the solar system***, *has a large and active international community, with significant expertise and heritage in the European Space Agency and Europe*.

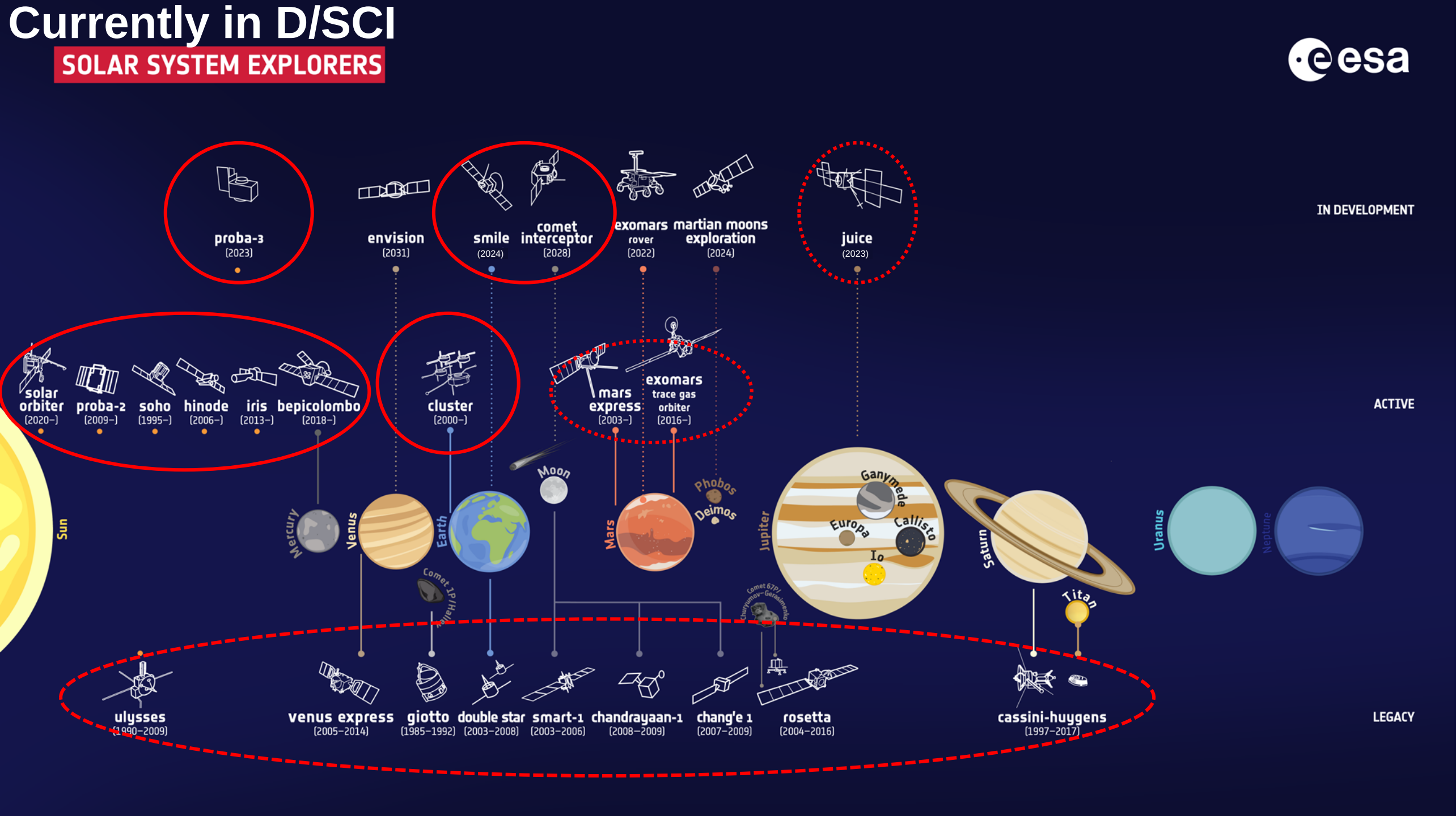
Several ESA directorates have activities directly connected with this topic:

The Directorate of Science:
Cluster, SOHO, Solar Orbiter, SMILE and the Heliophysics archive;
The Directorate of Earth Observation:
Swarm, products from SMOS and other Earth Explorer missions and Sentinels;
The Directorate of Operations:
Vigil, Distributed Space Weather Sensor System (D3S), Aurora and the Space Weather Service Network;
The Directorate of Human and Robotic Exploration:
many ISS and LOP-Gateway payloads;
The Directorate of Technology:
Engineering & Quality with expertise in developing instrumentation and models for measuring and simulating environments throughout the heliosphere;

ESA D/SCI activities in Heliophysics

Currently in D/SCI

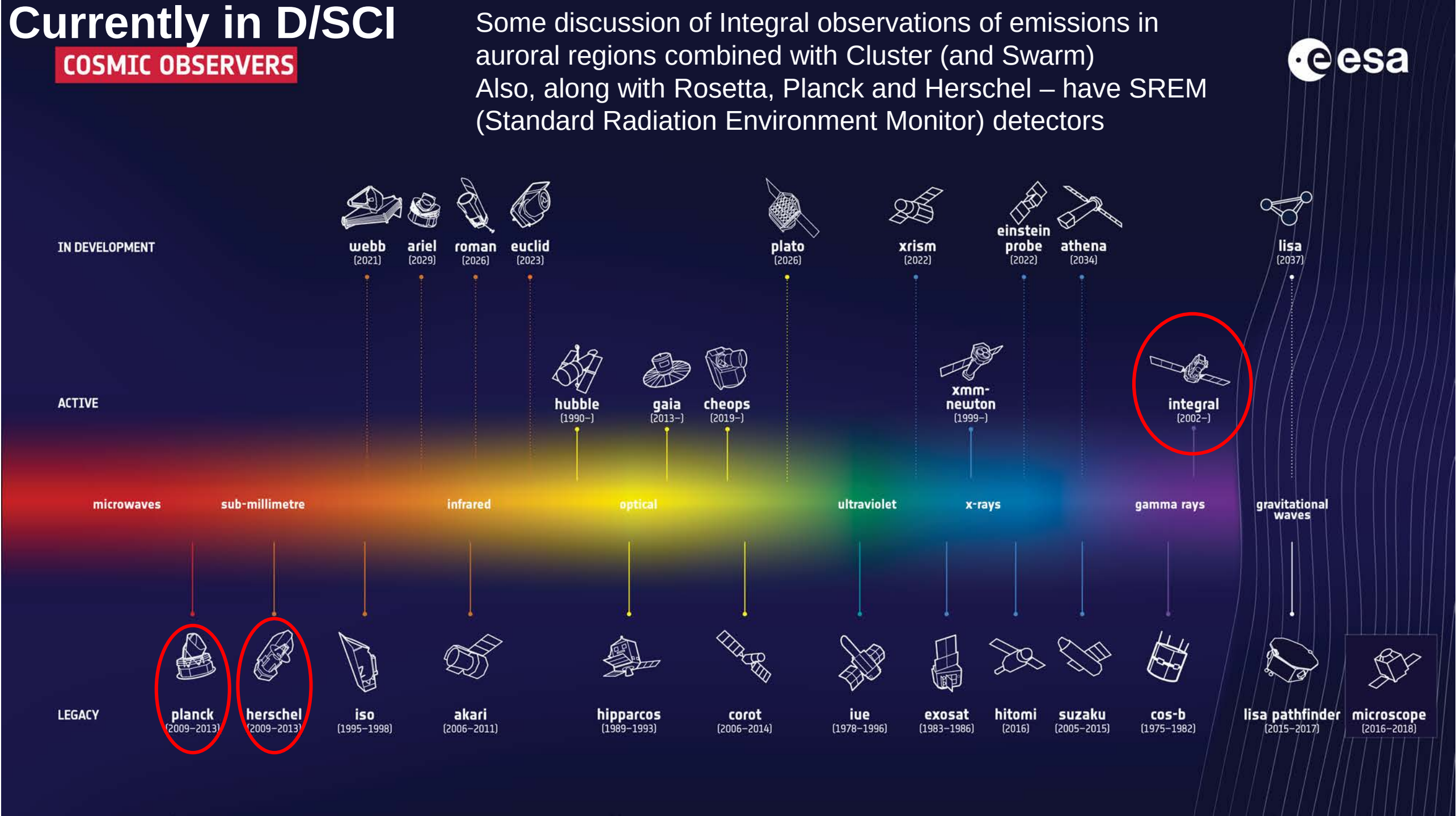
SOLAR SYSTEM EXPLORERS



Currently in D/SCI

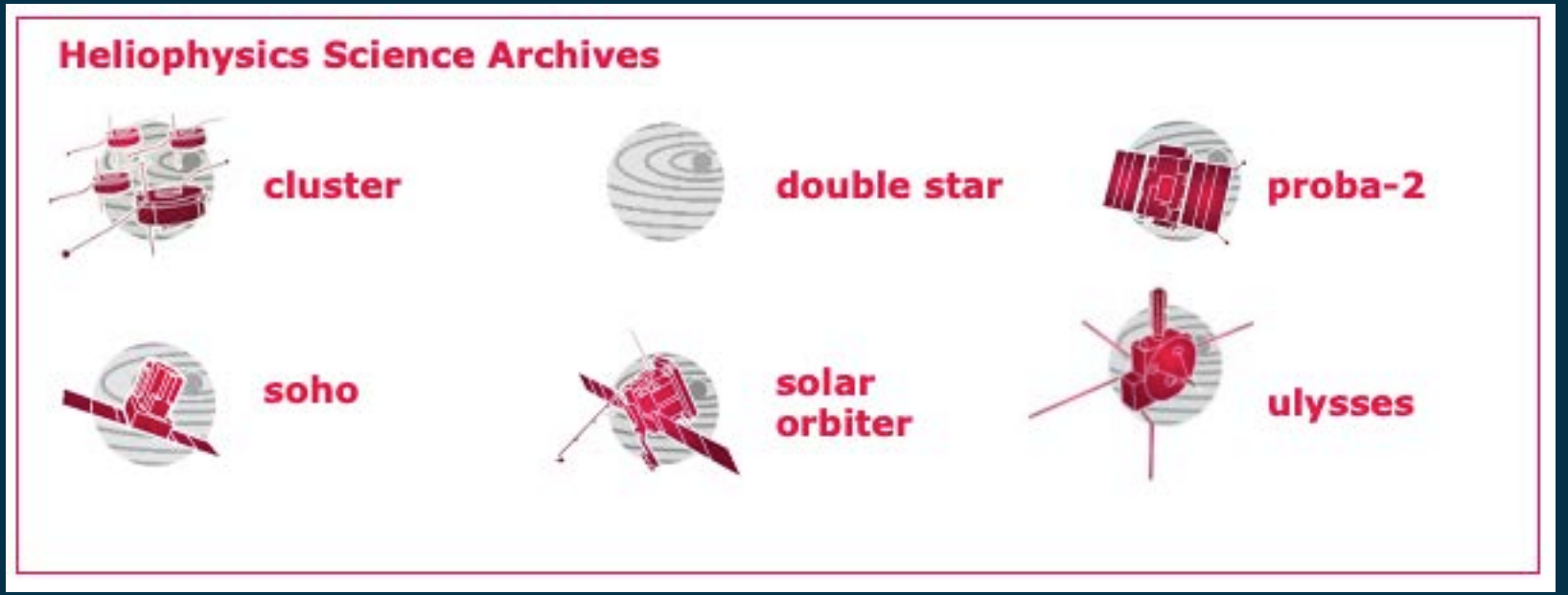
COSMIC OBSERVERS

Some discussion of Integral observations of emissions in auroral regions combined with Cluster (and Swarm)
Also, along with Rosetta, Planck and Herschel – have SREM (Standard Radiation Environment Monitor) detectors



ESA D/SCI Heliophysics archives

ESAC Science Data Archive (ESDC)
https://www.cosmos.esa.int/web/esdc/home



Also now bringing in other datasets from D/HRE

ESA D/EOP activities in Heliophysics

ESA-DEVELOPED EARTH OBSERVATION MISSIONS

2010

ERS-1
ERS-2
Envisat
MetOp-A
Proba-1
SMOS
GOCE
CryoSat
Swarm
Meteosat 10 (MSG)
MetOp-B
Proba-V

2015

Sentinel-1A
Sentinel-2A
Sentinel-3A
Meteosat 11 (MSG)
Sentinel-1B
Sentinel-2B
Sentinel-3B
Sentinel-5P
Sentinel-6 Michael Freilich
Aeolus
ALTIUS
Sentinel-1C
Sentinel-2C
Sentinel-3C
Biomass
EarthCARE
Sentinel-1D
Sentinel-2D
Sentinel-3D
FLEX
ESP-MACCS
HydroGNSS
TRUTHS
FORUM
Harmony
Earth Explorer-11

2020

MetOp-C
MTG-I1
Sentinel-5A MetOp-SG-A1
Sentinel-6B
CRISTAL-A
CIMR-A
ROSE-L-A
LSTM-A
CHIME-A
LSTM-B
CRISTAL-B
CIMR-B
ROSE-L-B
CHIME-B

2025

Arctic Weather Satellite
MetOp-SG-B1
CO2M-A
Sentinel-4A MTG-S1
MTG-I2
CO2M-B
CO2M-C
MTG-I3
Sentinel-4B MTG-S2

2030

Sentinel-5B MetOp-SG-A2
MetOp-SG-B2

○ Sentinel-1 ○ Sentinel-2 ○ Sentinel-3 ○ Sentinel-6

Continuation of Sentinel Next Generation Missions

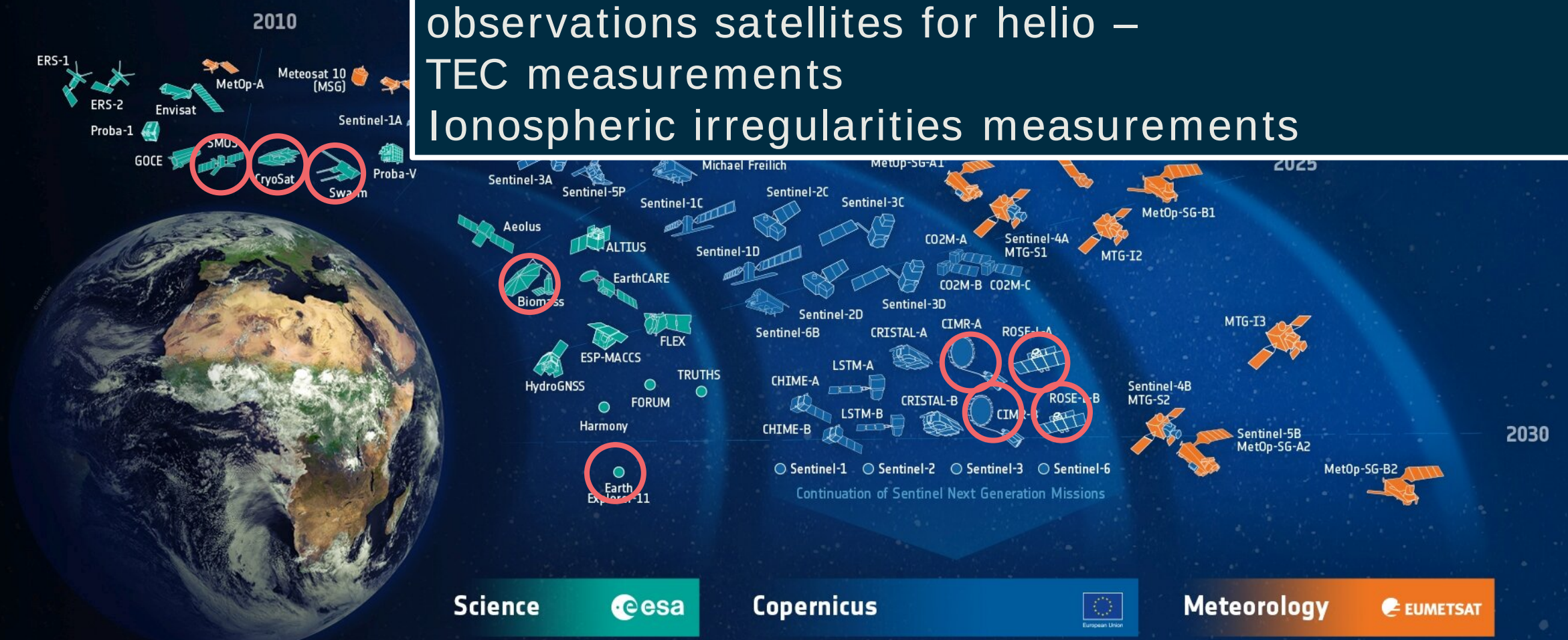
Science

Copernicus

Meteorology

ESA-DEVELOPED EARTH OBSERVATION MISSIONS

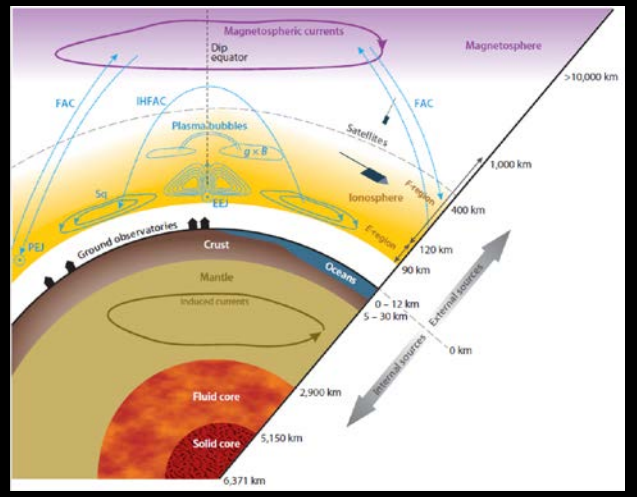
A number of potential opportunities from Earth observations satellites for helio –
TEC measurements
Ionospheric irregularities measurements

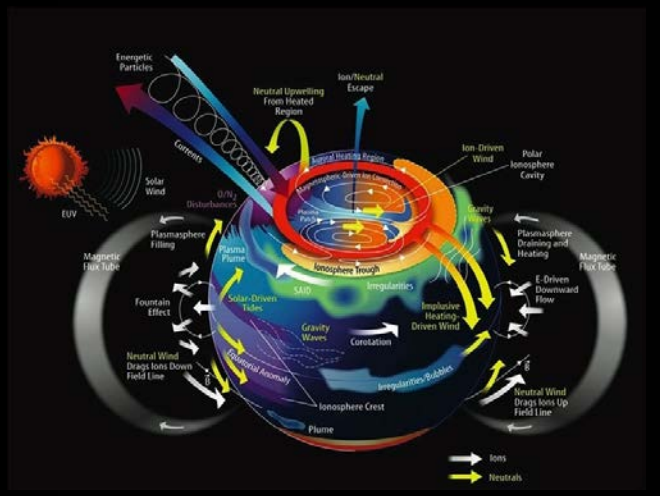


Swarm – magnetic field explorer

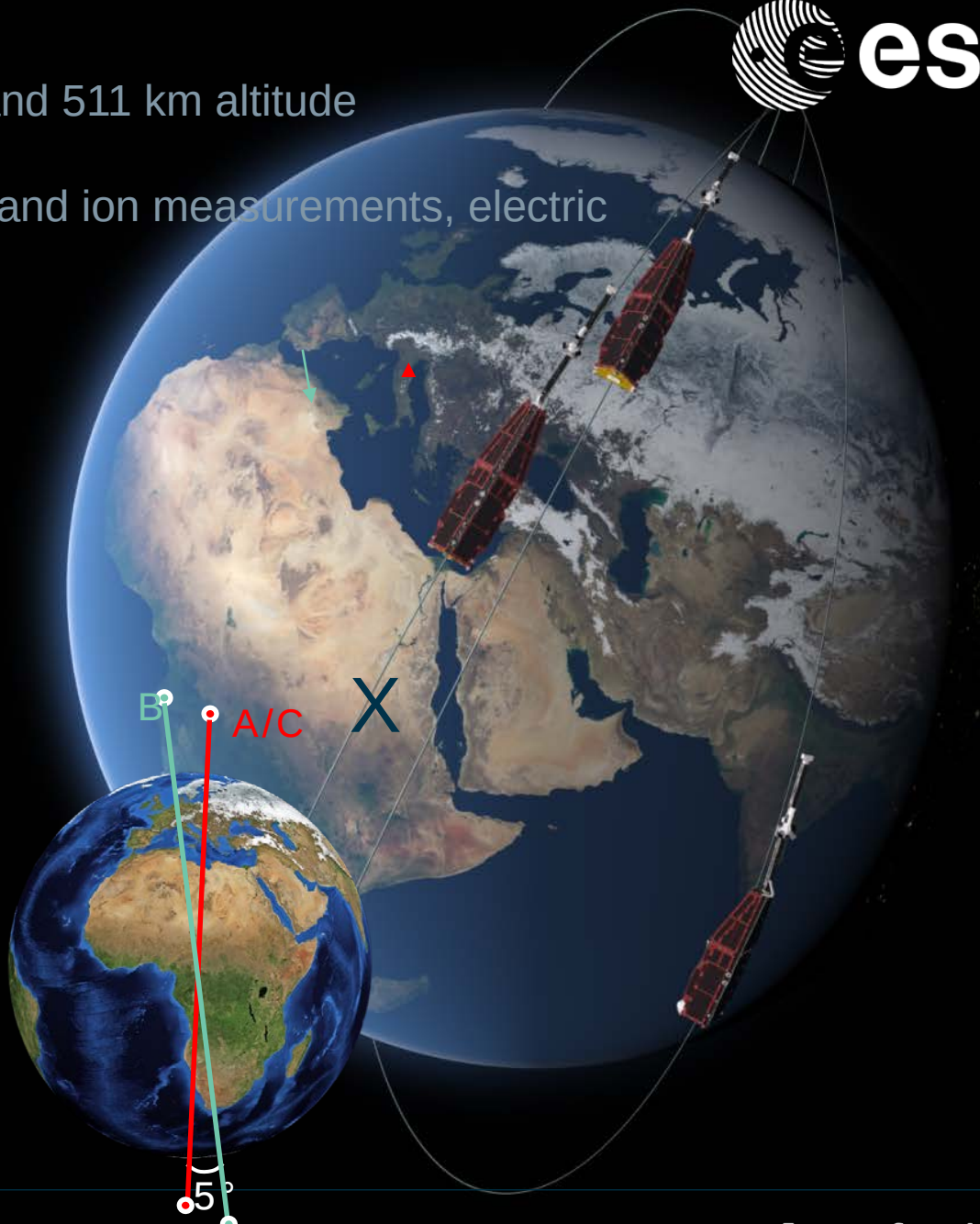
Launched in November 2013 into near polar orbit between 462 and 511 km altitude

3 identical spacecraft, 6 instruments on each (including electron and ion measurements, electric field, accelerometer and magnetic field).



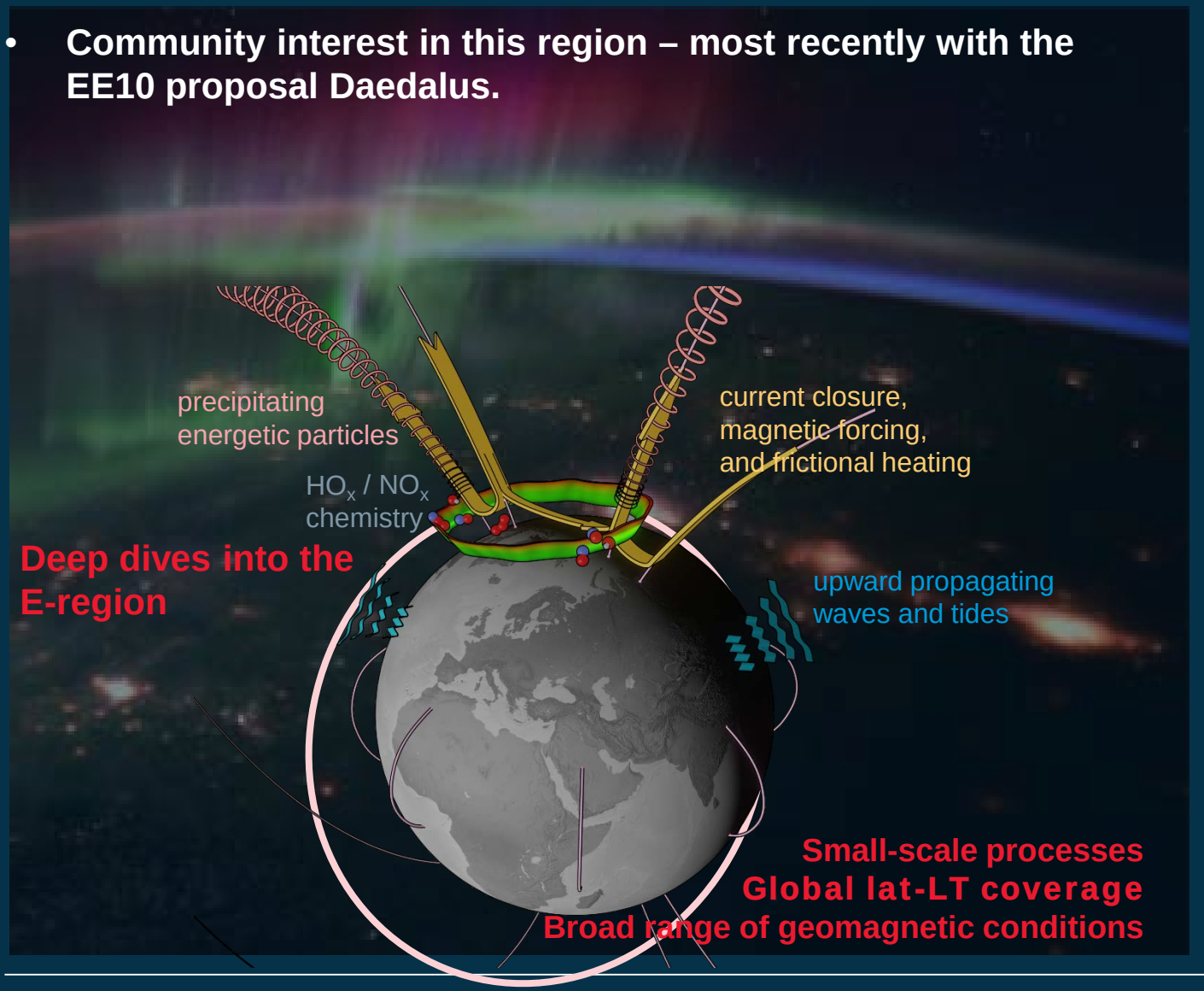


In March 2018, the CASSIOPE/e-POP mission was integrated into the Swarm constellation as Swarm-E.



Lower Thermosphere Ionosphere + EN-LoTIS-WG

- **Community interest in this region – most recently with the EE10 proposal Daedalus.**



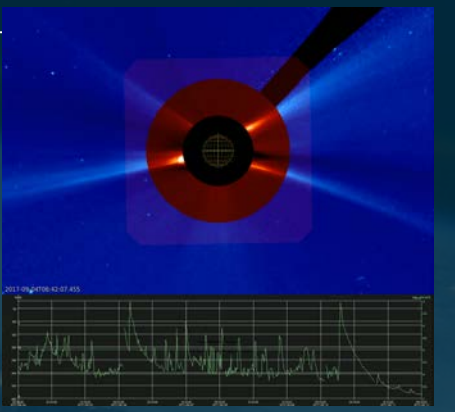
This has stimulated new cross-agency discussion (NASA Heliophysics and ESA D/EOP) and the subsequent formation of an international working group:

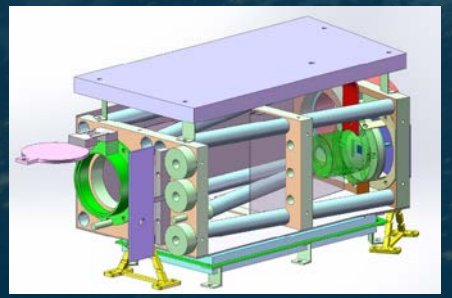
ESA NASA Lower Thermosphere Ionosphere Science (EN-LoTIS) Working Group

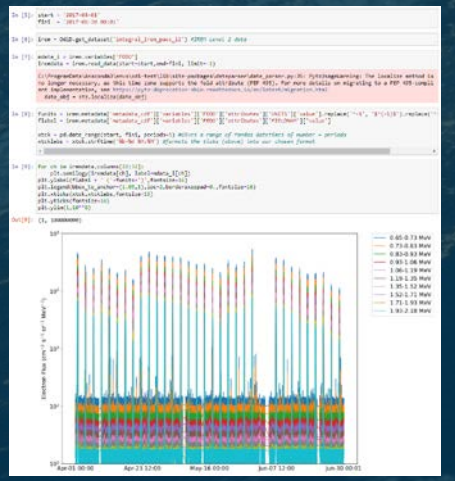
This WG is exploring agency cooperation on future lower thermosphere-ionosphere (LTI) satellite mission concepts, targeting *in situ observations* that enable advancements in understanding neutral-ion interactions from 100 - 200 km altitude, and the ionospheric E-region in particular.

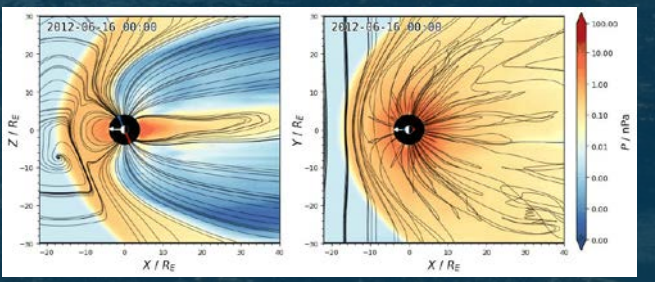
ESA D/TEC activities in Heliophysics

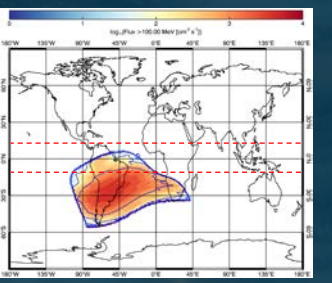
Space Environment and Effects , Wave Interaction & Propagation, CubeSat Systems, Small Sat Platform Optics and Opto-electronics, instrumentation, data provision, modelling, forecasting

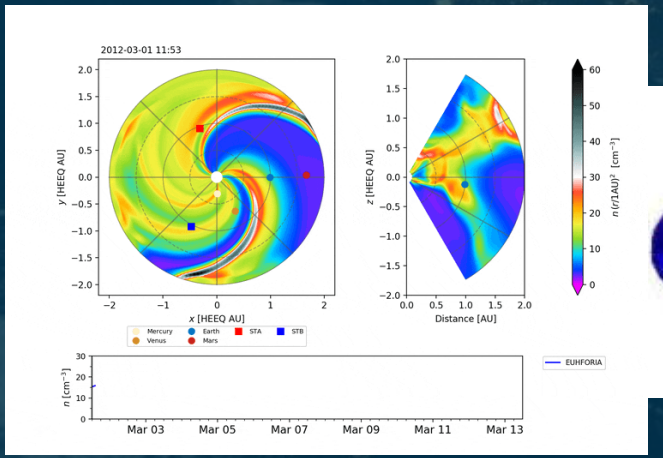


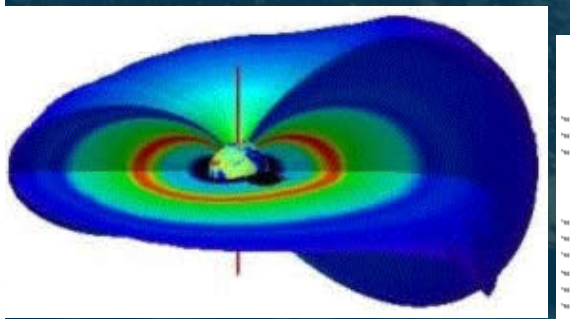


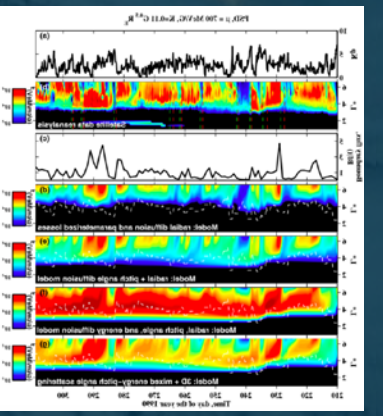


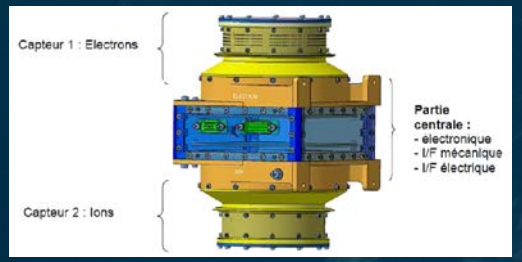








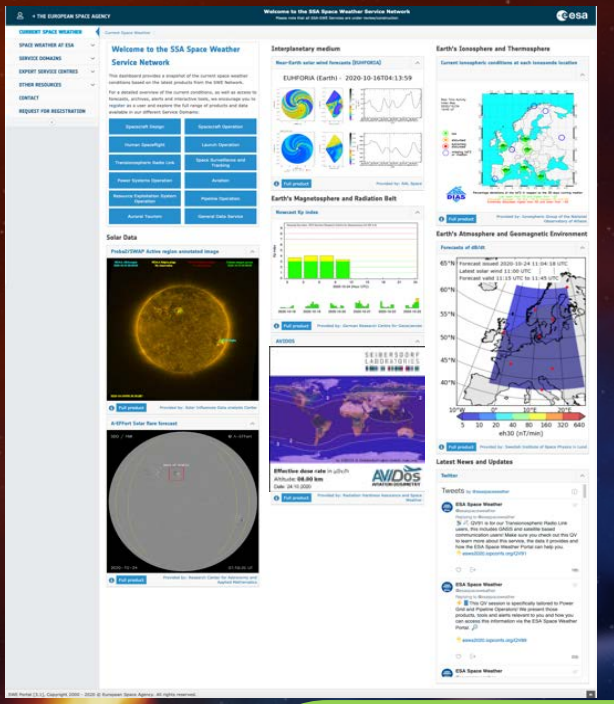


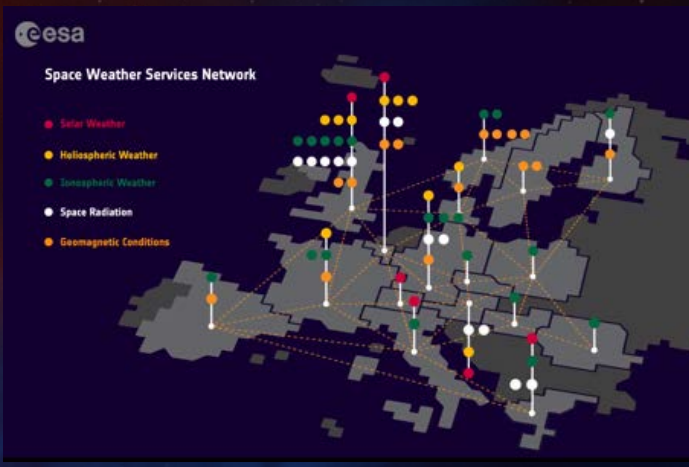


ESA D/OPS activities in Heliophysics

ESA SPACE WEATHER SERVICES AND ACTIVITIES

Missions to solar wind





L5 Vigil

Forecasting & Event detection

L1

DISTRIBUTED SPACE WEATHER SENSOR SYSTEM (D3S)

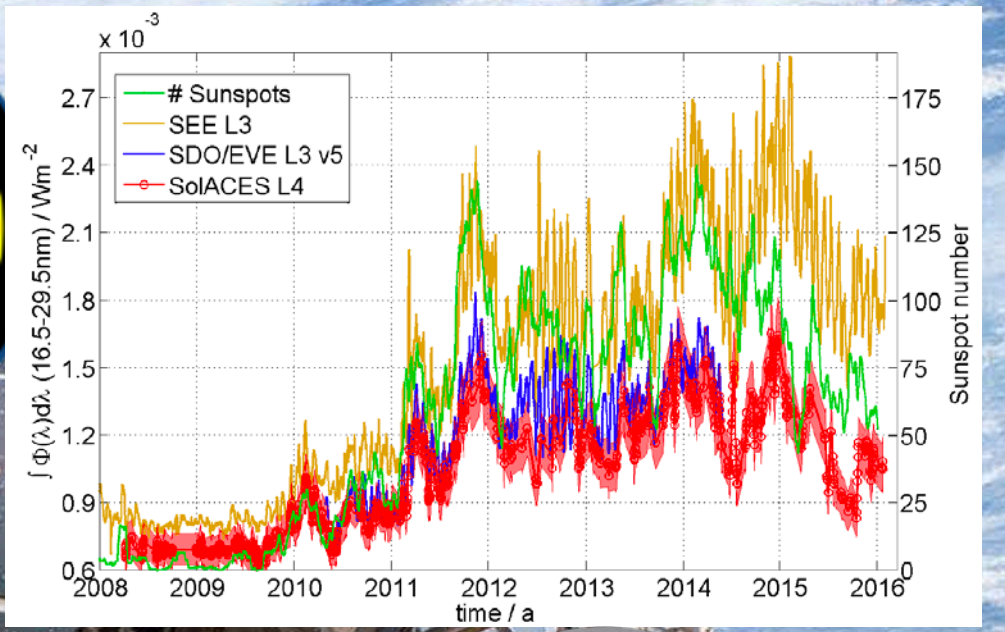
Aurora

Impact & SWE state monitoring

ESA D/HRE activities in Heliophysics

Present and past Heliophysics activities in D/HRE

SOLAR-ISS
- 9 years of operations up to Feb. 2017
- Data publicly available on ESA archive
- ~ solar cycle of irradiance



Atmosphere Space Interactions Monitor –ASIM -on ISS since 2018

lightning and bursts of gamma-rays from thunderstorm clouds.

Since December 2020 has an auroral mode when entering high magnetic latitudes.

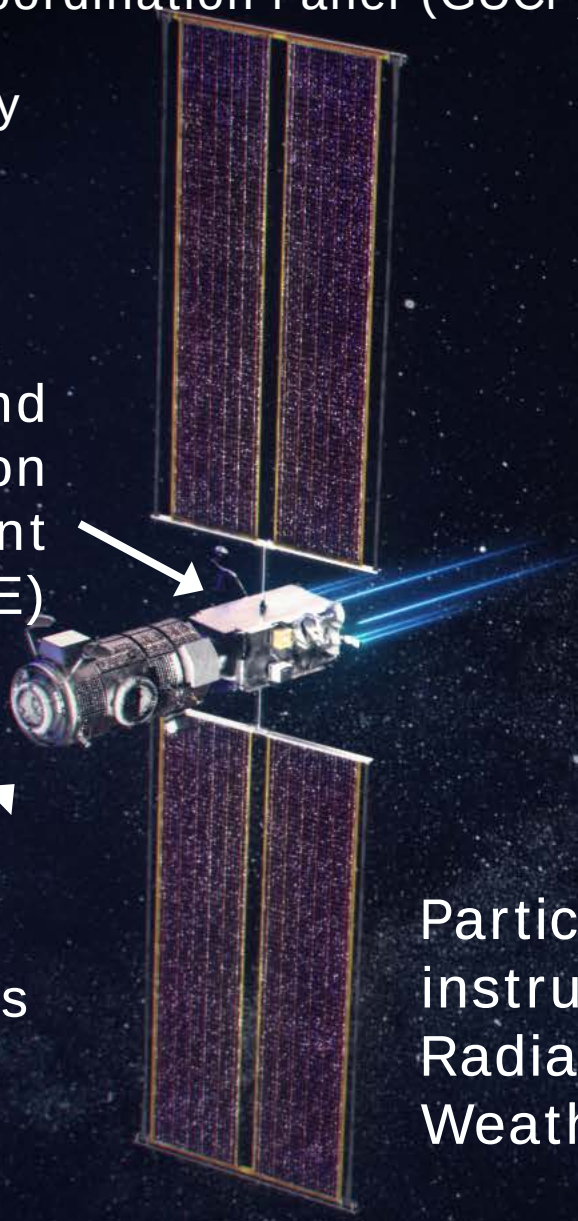
Many observations of X-ray aurora have already been made and analyses are ongoing.

Participation in Discipline Working Group on Heliophysics (DWG-H), providing input into Gateway Utilization Coordination Panel (GUCP). Multi-agency including NASA, ESA, JAXA and CSA.

Initial Gateway Modules

Power and Propulsion Element (PPE)

Habitation and Logistics Outpost (HALO)



First Science Payloads:

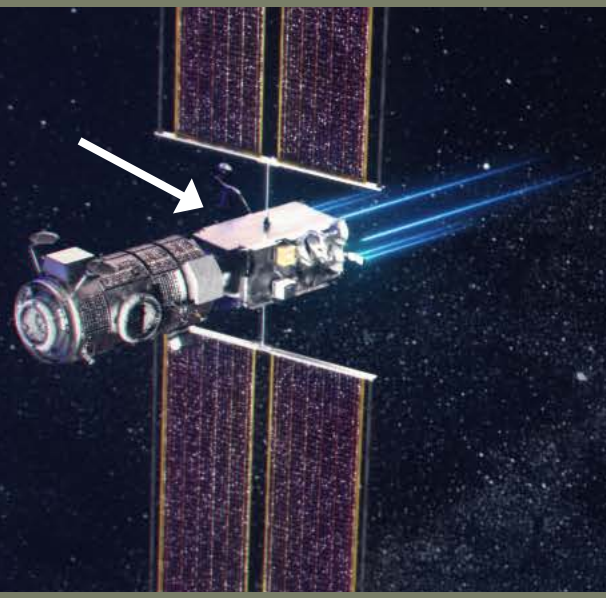
- HERMES[1] – NASA
- ERSA[2] – ESA*
- IDA[3] – ESA/JAXA

Particles and fields instrumentation for Radiation and Space Weather studies

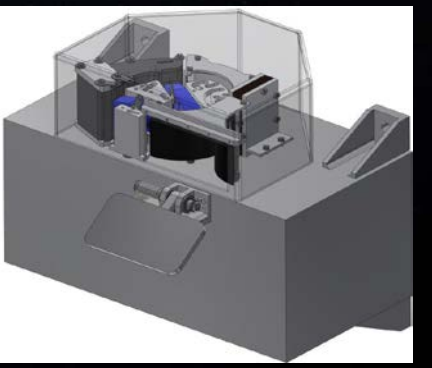
- [1]Heliophysics Environmental and Radiation Monitoring Experiment Suite (HERMES)
- [2]ESA Radiation Sensor Array (ERSA)
- [3]Internal Dosimeter Array (IDA)
- * +JAXA dust instrument

Also had Topical Team and industry study examining science and then instrumentation to study exosphere of moon
And a call:

Reserve Pool of Science Activities for the Moon: A SciSpacE Announcement of Opportunity



Embarking NILS: first measurement of negative ions backscattered and sputtered from the lunar surface on Chang'e 6
Chang'e6 will be the first mission to return samples from the South Pole and/or the far side South Pole Aitken Basin in **2024**



ESA Heliophysics Working Group TOR

Background:

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.

The following tasks are assigned to the HWG:

- **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.**

To achieve their tasks, the HWG will:

- **Convene regularly (every 3-6 months);**
- **Set up dedicated internal workshops to build on existing synergies;**
- **Set up dedicated community workshops to build on these internal synergies and receive inputs from the scientific community that cuts across ESA programmes;**

The members of the HWG are appointed by the relevant Directors.

The lifetime of the HWG will be 3 years, renewable by decision of all involved Directors.

ESA Heliophysics Working Group TOR cont.

In the HWG meetings, each member will present their directorates ongoing and future activities in the area of Heliophysics, along with related scientific community related information where relevant (from Directorate level working groups for example).

Each respective member of the HWG will be able to access information relevant to their directorates activities to facilitate this.

The HWG will discuss on the ongoing and planned activities in the Directorates, and will identify any potential science synergies. Minutes and actions (if necessary) will be issued 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.

Members:

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

ESA Heliophysics Working Group

This is an INTERNAL activity, but it aims to enable us to do better at serving the general Heliophysics community

There is no money for this activity, so we have initially focused on ”Low Hanging Fruit”, activities common to each directorate which could be enhanced by better coordination and communication

Set up three (now two) focus groups :

1) **Archiving – how to improve inter-directorate data access**
2) **Ground based observations – how to better connect to our missions**
3) **Rocket campaigns – can we coordinate better with potential activities/opportunities**

Archiving Forum

Archiving Forum kick off conclusions

- Improving discovery (for both data and knowledge)
- Ensuring communication and alignment of data formats and versioning
- Some hands-on work with access tools and working examples
- For the future – a community workshop.

Ground based forum

The main outcomes of the ESA HWG Ground Based Forum KO meeting were:

- **<u>Discovery and information access</u> is a key point to address to encourage more collaboration.**
- **Presentations from ground based actors on how they work and their needs and wishes for our missions. (This could include some presentation from CSA on moving the ASIs to a facility). This could eventually be expanded to a more dedicated workshop.**
- **The topic of archiving ground based data with our own spacebased data.**
- **Looking forward to future missions, how can MoUs and agreements be set up and missions be better prepared for these activities. This could /should include Guest Investigator programmes, which ongoing missions could also consider.**
- **Look at how Astronomy mission connect to ground.**
- **Presentation on Space Weather ground based facilities**

Sounding Rocket forum

The main outcomes of the Rocket Forum KO meeting were:

- **HRE has a regular call for opportunities for the science community. We should ensure that the heliophysics community is aware of this. This was done for the last call and should continue.**
- **During the meeting discussion, it was considered that the appropriate information on opportunities had been provided and that there were no additional activities to suggest, and so a dedicated full meeting was not needed. Instead, any rocket related topics would be brought up to the Ground based Forum.**

ESA Heliophysics Working Group – so what?

Has set up formal and regular interaction across directorates

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– DISCOVERABILITY

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– BETTER COMMUNICATION

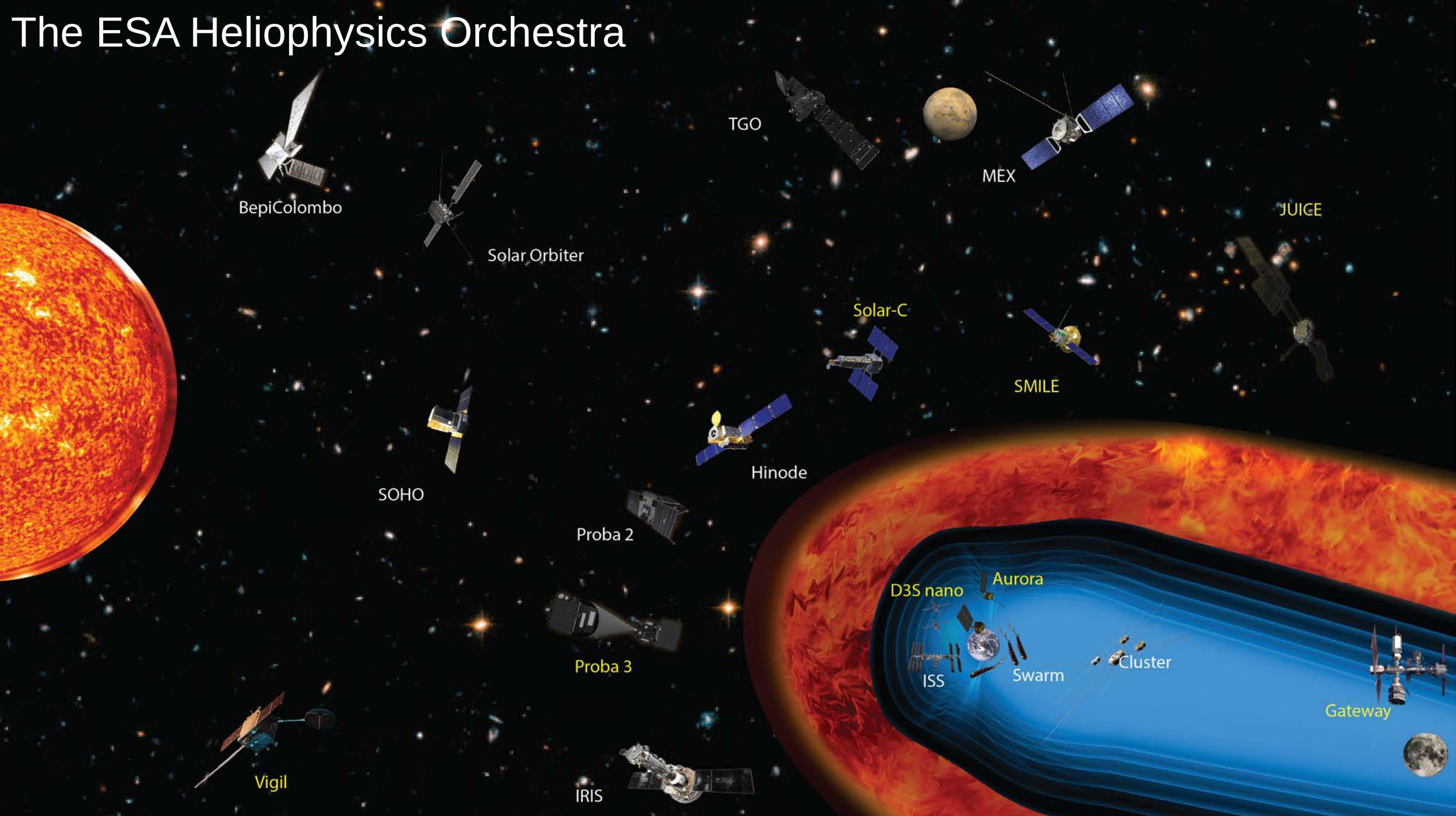
– DISCOVERABILITY

Looking at “low hanging fruit”

Archiving and ground-based community interactions

Better interactions inside ESA will benefit the community

The ESA Heliophysics Orchestra



ESA Heliophysics Working Group – Conclusions

ESA has started an internal multi directorate activity connecting activities in area of Heliophysics.

General information and minutes etc on D/SCI hosted pages https://www.cosmos.esa.int/web/esa-heliophysics/home

Provides a mechanism for all interested ESA colleagues to interact.

Aim to eventually open things to community.

Already starting to have online seminars.

Dedicated community workshops to follow.

Next meeting 16th December