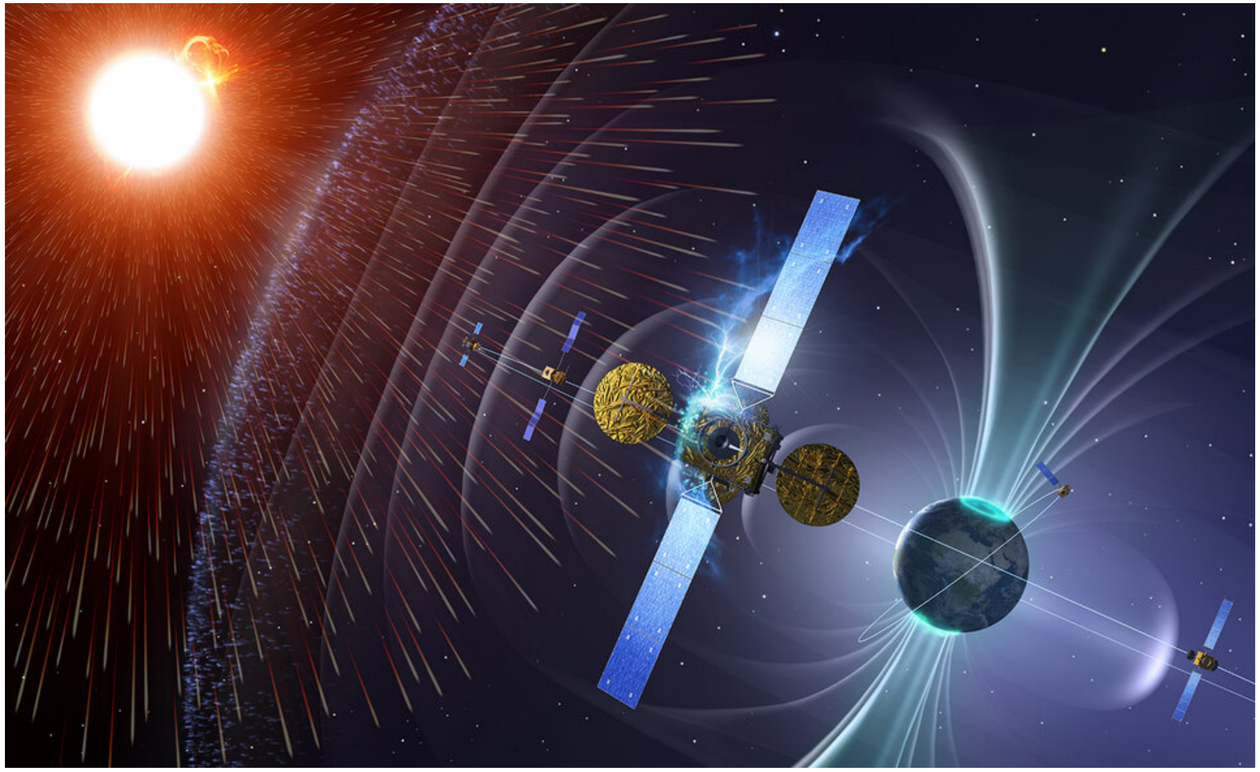
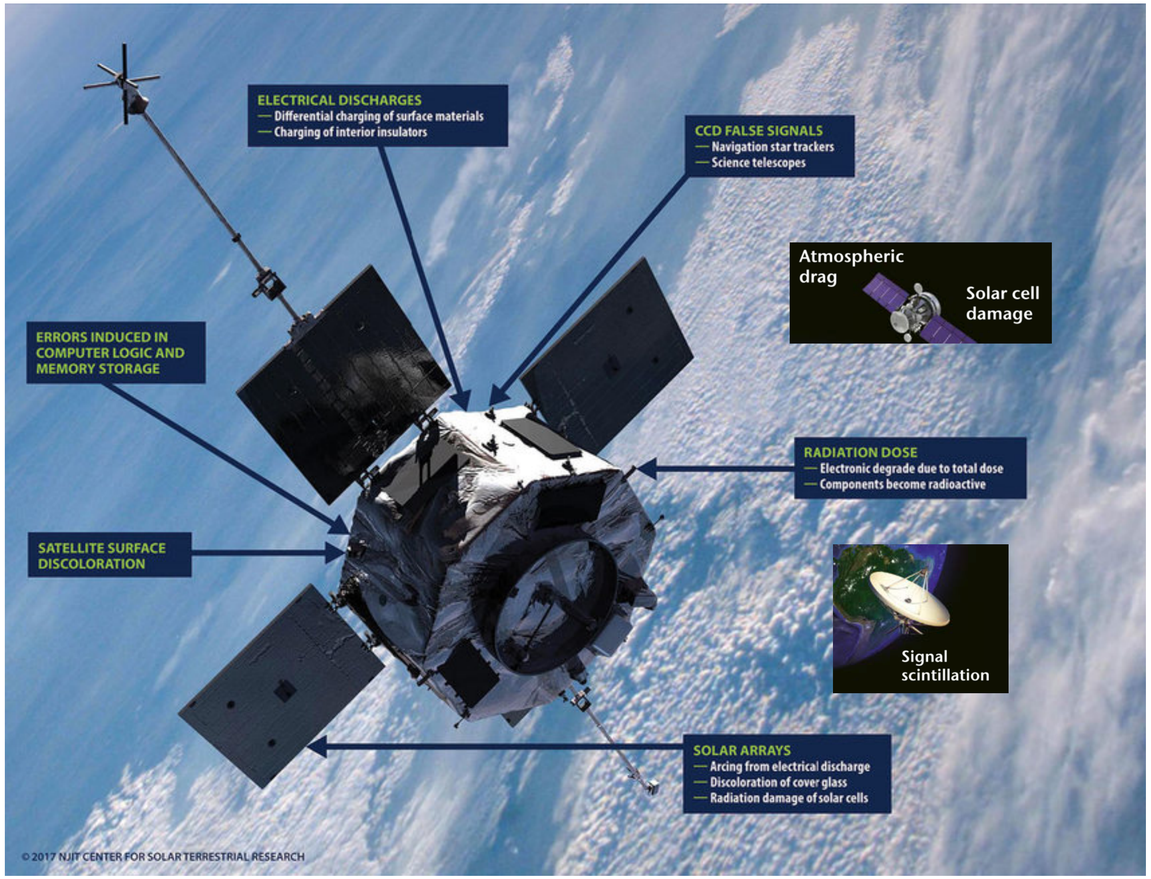
Space Weather Service for Resilient Satellite Operations (SWOPSAT)

Y. Maneva and the STCE SWOPSAT team

SWOPSAT Concept

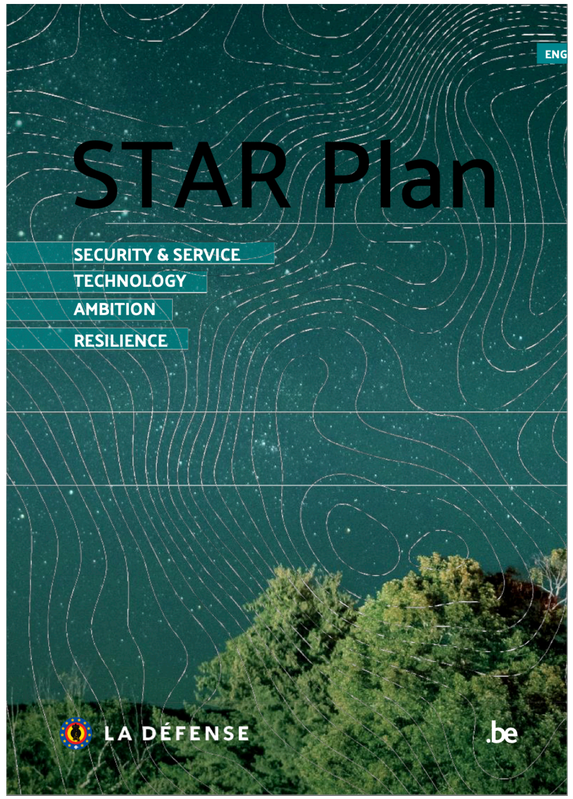
Monitor, forecast, warn for and evaluate space weather effects on LEO-satellites





SWOPSAT Goal

Address the needs of Belgian Defense STAR Plan



Space

Defence needs guaranteed access to space services in the key areas of satellite communications and intelligence, surveillance and reconnaissance (ISR), positioning, navigation and synchronisation services. This requires the support of qualified staff and participation in research and development programmes.

Defence contributes to the security and resilience of national and allied space assets. To this end, it will expand its national and international involvement in the areas of space knowledge development and space traffic management. This development of knowledge can take the form of participation in international organisations or pooled capabilities, the development of space weather services or sensors, or an autonomous national niche capability.

Royal Observatory *of* Belgium

SWOPSAT Coordinator

Royal Observatory of Belgium (ROB)

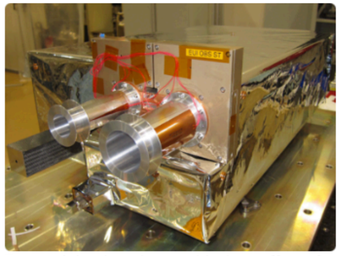
Ground Observations



The SIDC monitors the level of solar activity from the photosphere to the corona with ground based instruments located in Uccle and Humain.

Read more

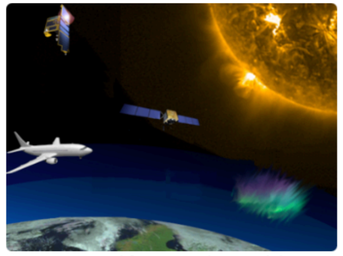
Space Instruments



To avoid the disturbing or blocking effect of the Earth atmosphere, EUV observations of the solar corona need to be made from space...

Read more

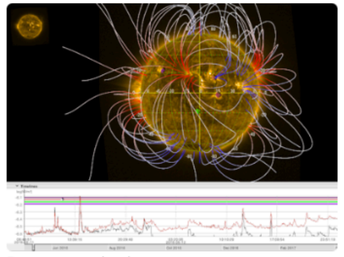
Space Weather & Climate



We monitor and forecast solar variability to provide information services to society and industry about the influence of space weather and climate.

Read more

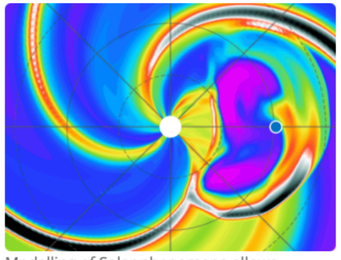
Data Processing & Distribution



Data processing is necessary to extract relevant information for research studies, whereas data distribution and visualization are part of ROB open data policy.

Read more

Modeling



Modelling of Solar phenomena allows scientists to test theories and to predict Space Weather phenomena and their impact on Earth.

Read more

Supporting Research



The SIDC shares and expands its expertise through interaction with both upcoming and experienced researchers.

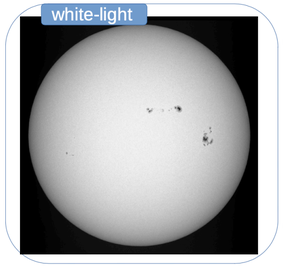
Read more

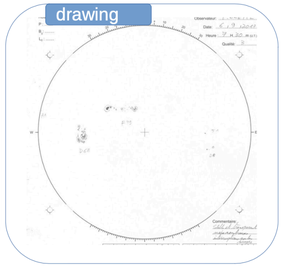
Royal Observatory of Belgium

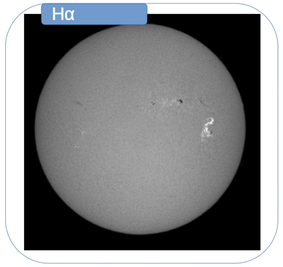
SWOPSAT Coordinator

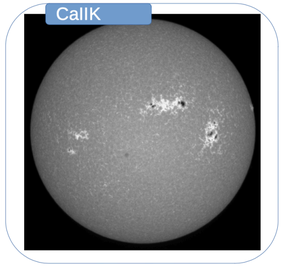
Royal Observatory of Belgium (ROB)



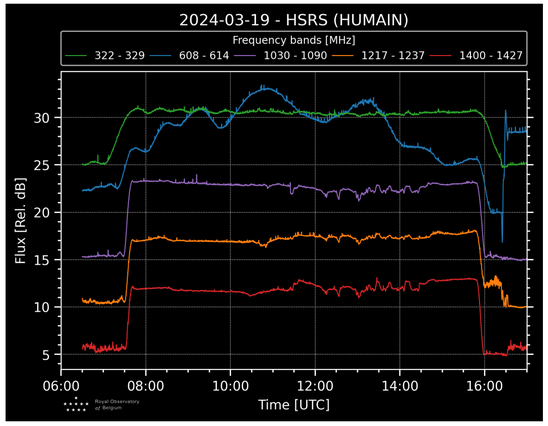


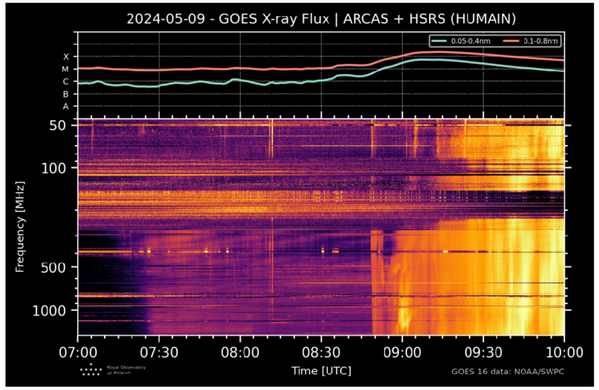


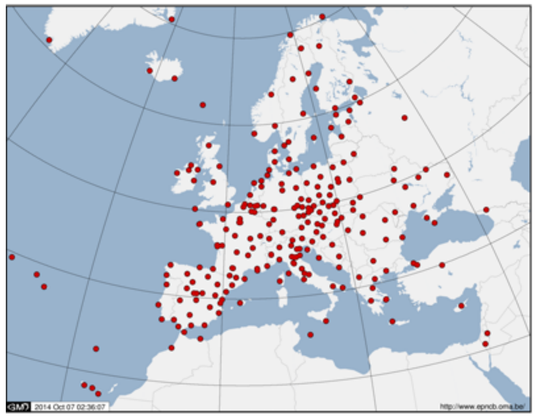


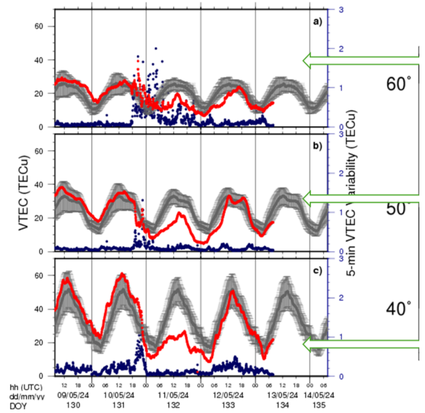


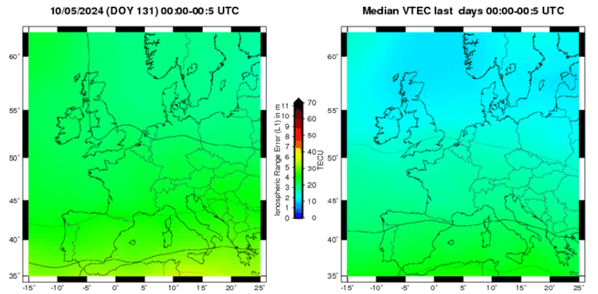


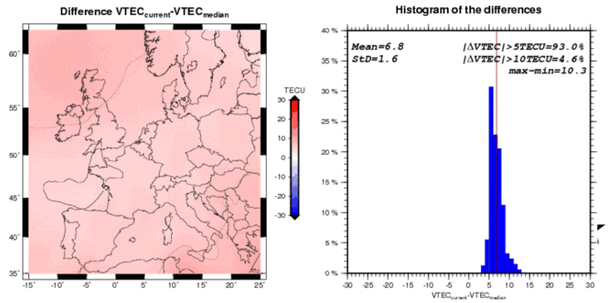








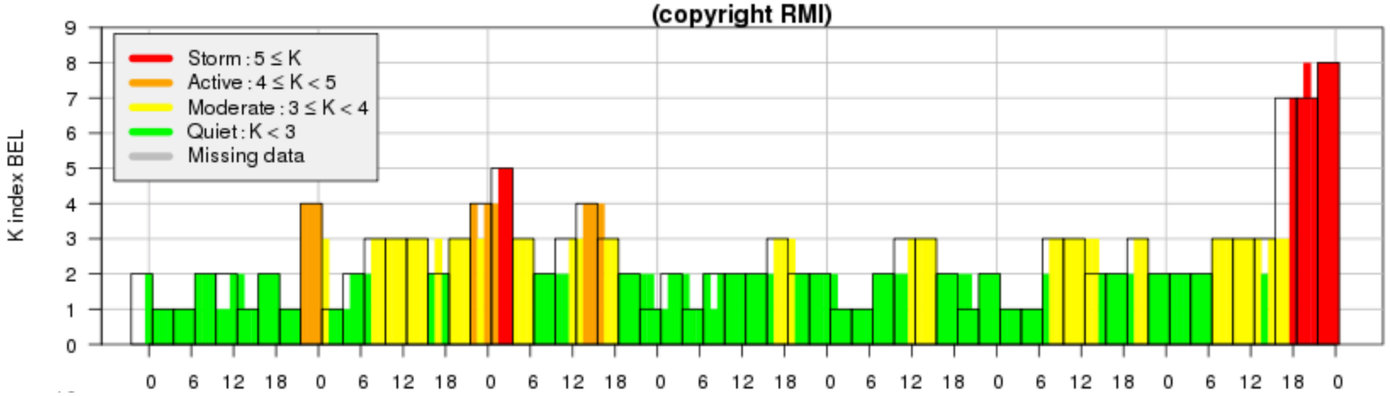


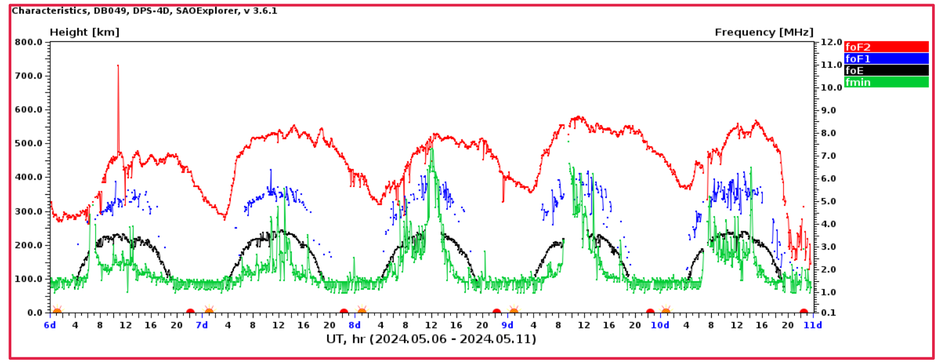


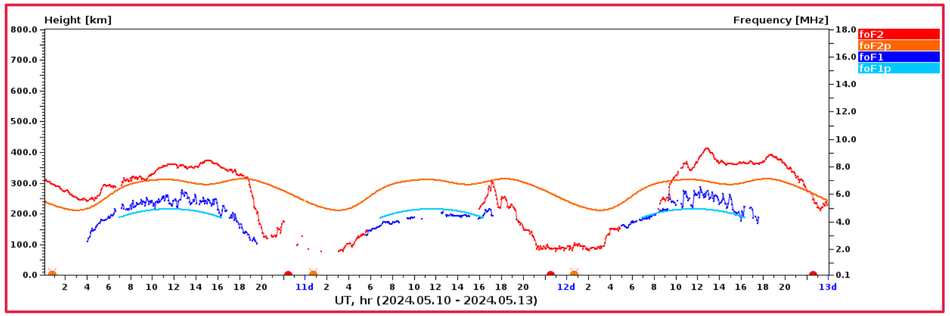
Royal Observatory *of* Belgium

SWOPSAT Partners

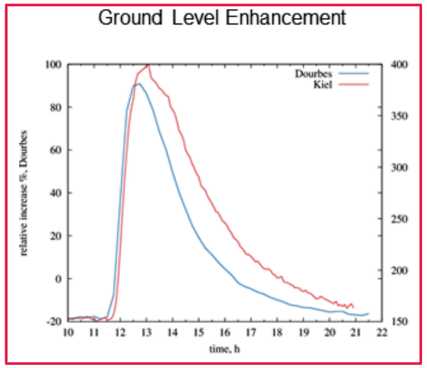
Royal Meteorological Institute (RMI)







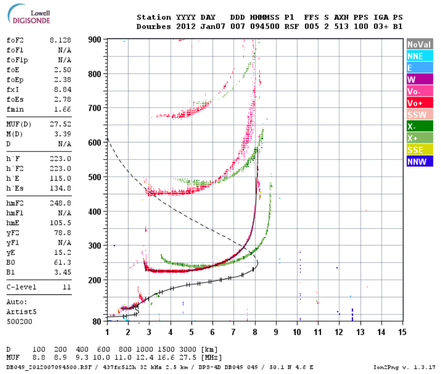




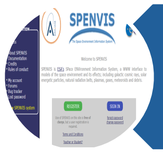




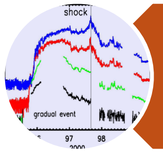




BIRA-IASB



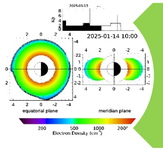
SPENVIS (Space ENVironment Information System)



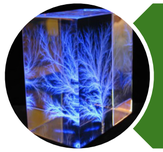
SEPEM (Solar Energetic Particle Environment Modelling)



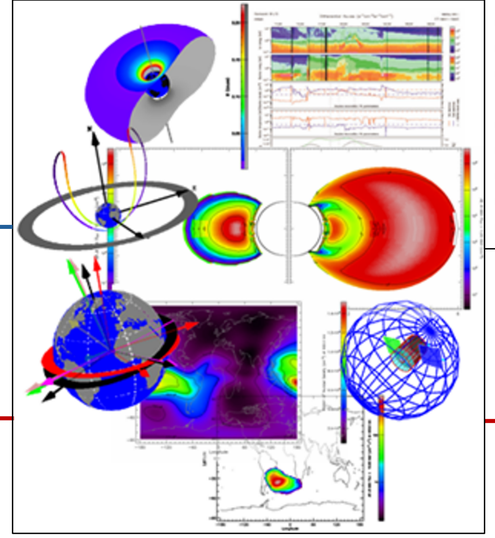
COMESEP (COronal Mass Ejections and Solar Energetic Particles)



SPM (SWIFF Plasmasphere Model)



ICEA (Ir ternal Charging Environm ent and Analysis



- TRAP
- SEP
- GCR

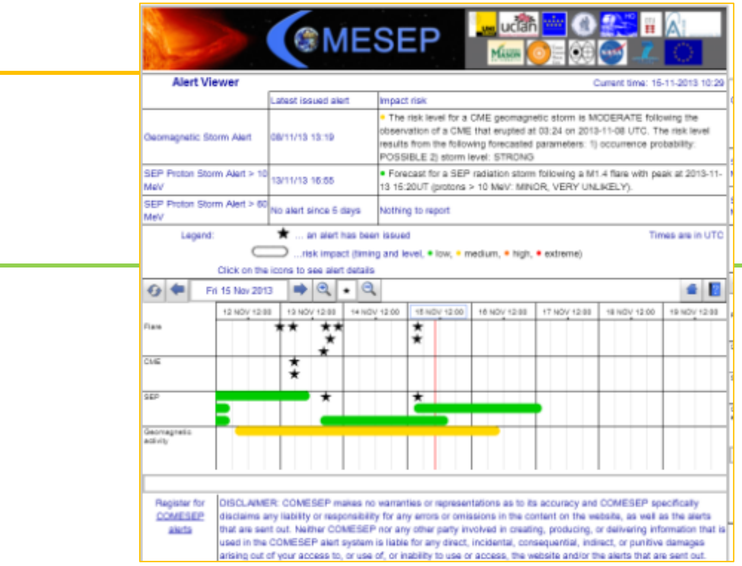
- TID
- TNID
- SEU
- SAD
- ESD

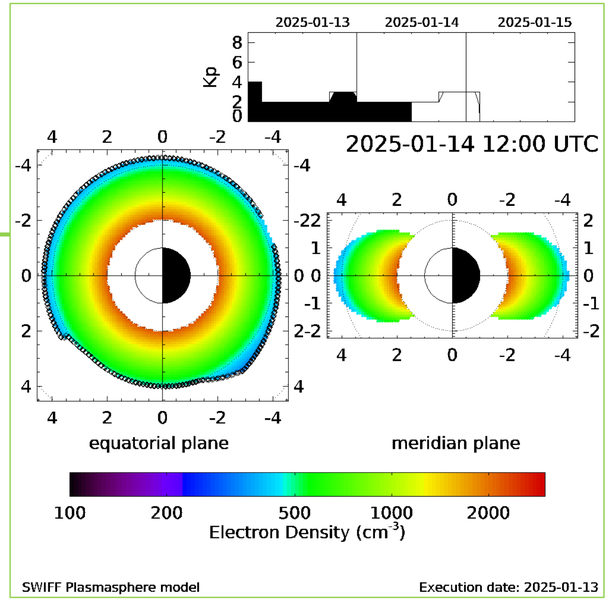
Data sources

Overview of the implemented datasets

Raw dataset overview

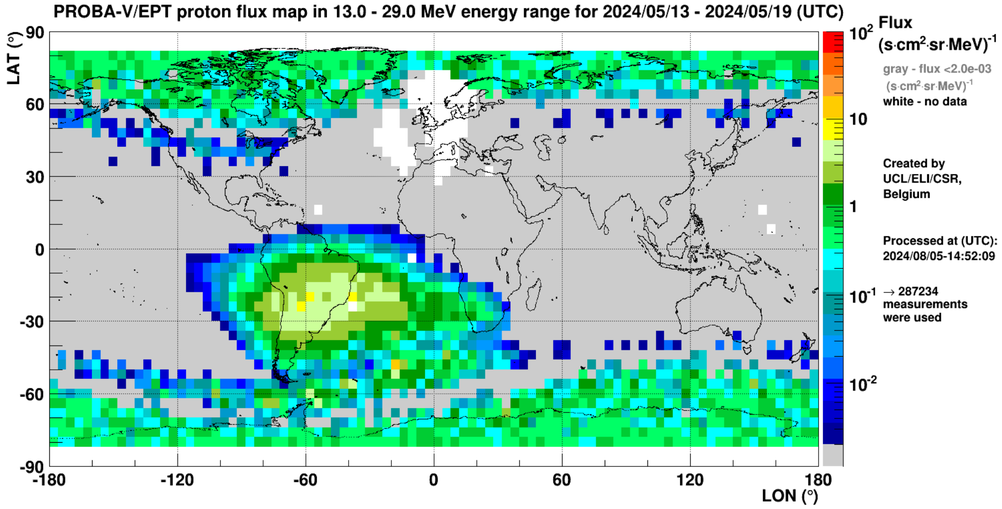
Dataset Name	Spacecraft	Instrument	Particle(s)	Time Resolution (s)	Epoch Range	Source
SMS01 5 minute G files	SMS01	SEM	p^+, e^-	300	1974-07-01–1975-10-31	https://satdat.ngdc.noaa.gov/sem/goes/data/full/fits/
SMS02 5 minute G files	SMS02	SEM	p^+, e^-	300	1975-02-01–1978-03-31	https://satdat.ngdc.noaa.gov/sem/goes/data/full/fits/
GOES01 5 minute G files	GOES01	SEM	p^+, e^-	300	1976-01-01–1978-05-31	https://satdat.ngdc.noaa.gov/sem/goes/data/full/fits/
GOES02 5 minute G files	GOES02	SEM	p^+, e^-	300	1977-08-01–1983-05-31	https://satdat.ngdc.noaa.gov/sem/goes/data/full/fits/
GOES03 5 minute G files	GOES03	SEM	p^+, e^-	300	1978-07-01–1979-12-31	https://satdat.ngdc.noaa.gov/sem/goes/data/full/fits/
GOES05 5 minute G files	GOES05	SEM	p^+, e^-	300	1984-01-01–1987-03-31	https://satdat.ngdc.noaa.gov/sem/goes/data/avg/
GOES06 5 minute G files	GOES06	SEM	p^+, e^-	300	1983-05-01–1994-12-31	https://satdat.ngdc.noaa.gov/sem/goes/data/avg/
GOES07 5 minute G files	GOES07	SEM	p^+, e^-	300	1987-03-06–1996-08-31	https://satdat.ngdc.noaa.gov/sem/goes/data/avg/
GOES08 5 minute G files	GOES08	SEM	p^+, e^-	300	1995-01-01–2003-06-17	https://satdat.ngdc.noaa.gov/sem/goes/data/avg/
GOES09 5 minute G files	GOES09	SEM	p^+, e^-	300	1996-04-01–1998-08-31	https://satdat.ngdc.noaa.gov/sem/goes/data/avg/
GOES10 5 minute G files	GOES10	SEM	p^+, e^-	300	1998-07-01–2009-12-31	https://satdat.ngdc.noaa.gov/sem/goes/data/avg/
GOES11 5 minute G files	GOES11	SEM	p^+, e^-	300	2000-07-01–2011-02-28	https://satdat.ngdc.noaa.gov/sem/goes/data/avg/
GOES12 5 minute G files	GOES12	SEM	p^+, e^-	300	2003-01-01–2010-09-30	https://satdat.ngdc.noaa.gov/sem/goes/data/avg/
GOES13 5 minute G files	GOES13	EPS	p^+, e^-	300	2010-05-01–2017-12-31	https://satdat.ngdc.noaa.gov/sem/goes/data/avg/
SMS01 5 minute A files	SMS01	SEM	He	300	1974-07-01–1975-10-31	https://satdat.ngdc.noaa.gov/sem/goes/data/full/fits/

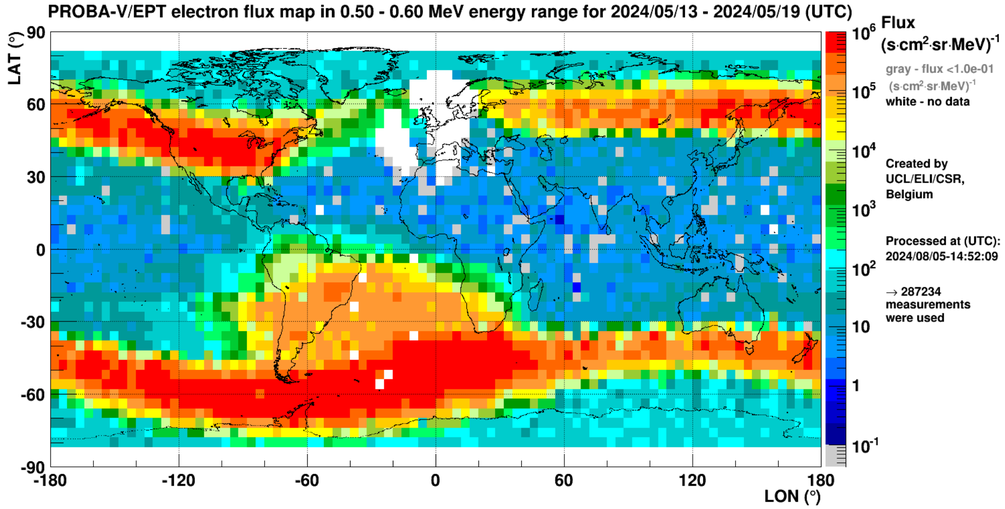


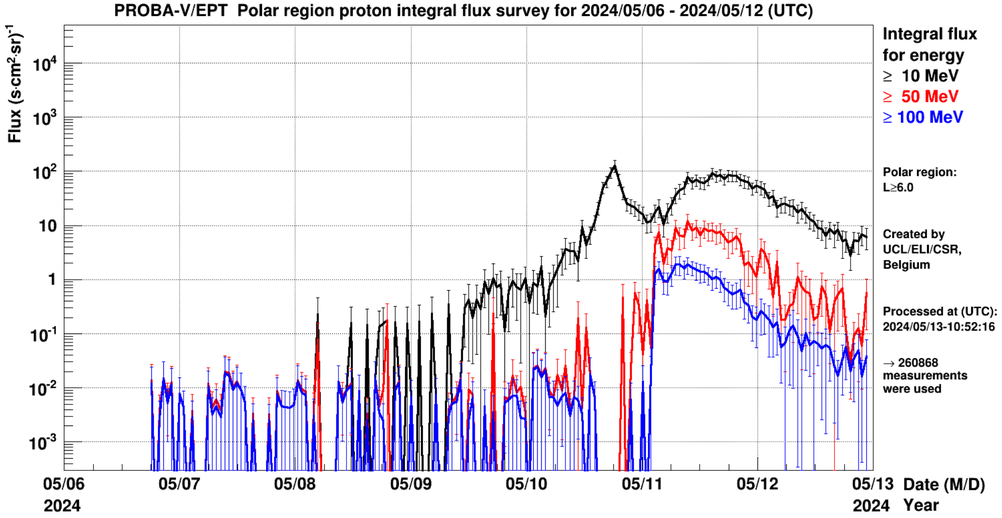


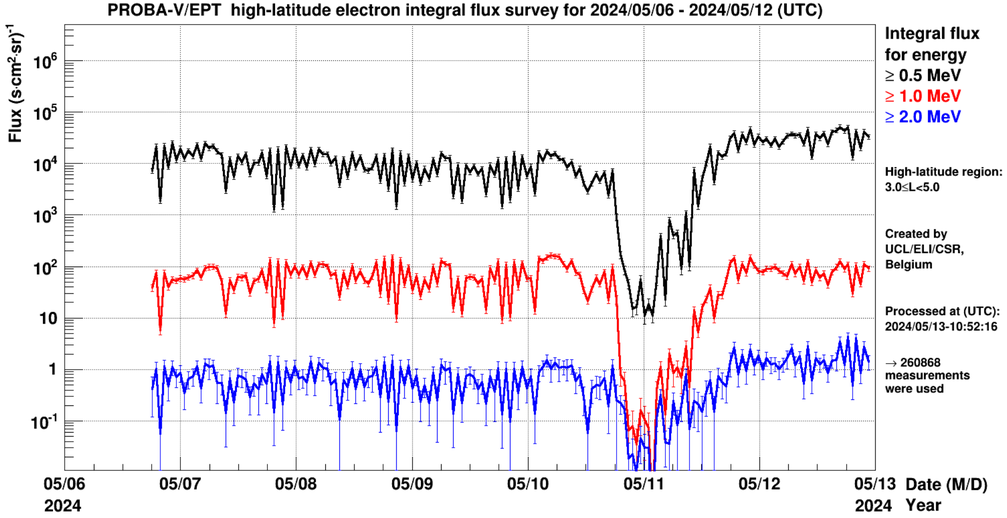
Date	07/01/2025	08/01/2025
Kapton (0.0 mm)		
Polythene (0.0 mm)		
Teflon (0.0 mm)		
Kapton (0.5 mm)		
Polythene (0.5 mm)		
Teflon (0.5 mm)		

PROBA-V data (May 2024 event)





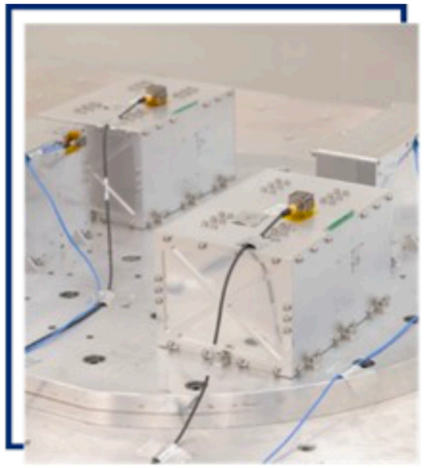




Industrial Partner

AeroSpaceLab:

Satellite anomalies & User requirements +
Optional Payload



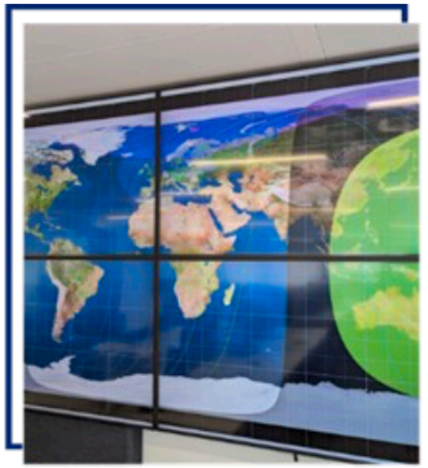
We design and manufacture
In-house subsystems



Used to develop
satellite platforms

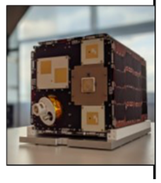


Integrating payload to deliver
turnkey satellites

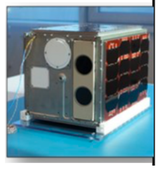


Generating value through
in orbit operations

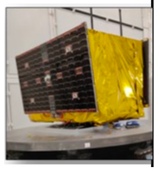
Arthur-1



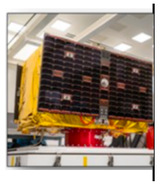
PVCC



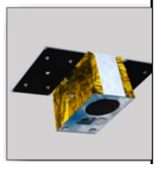
Grégoire



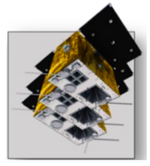
SPIP



VHR



RFS



LEO
Nanosats/Cubesats

SWOPSAT in a nutshell

WP1

Match past satellite anomalies with observed space weather

WP2

Impact matrix & service definition

WP3

Run a prototype service for 6 months

WP4

Make an assessment of the usefulness

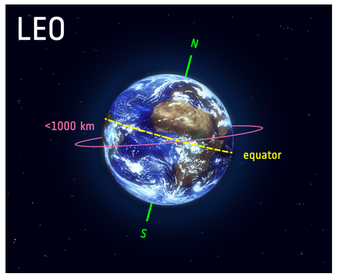
WP5

Identify data gaps and needs for new payload

WP5+ (optional)

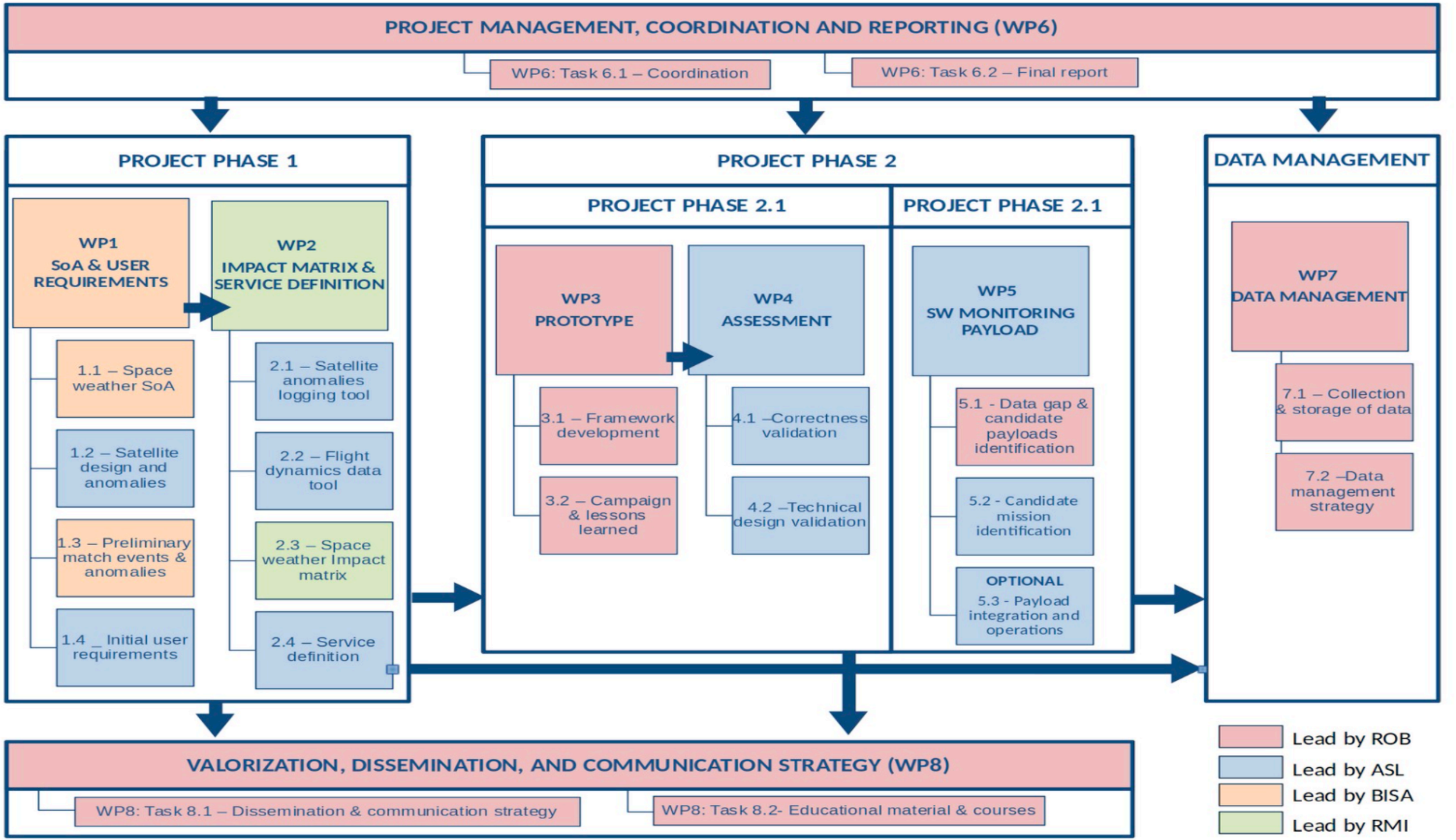
Payload integration & operation

SWOPSAT key aspects

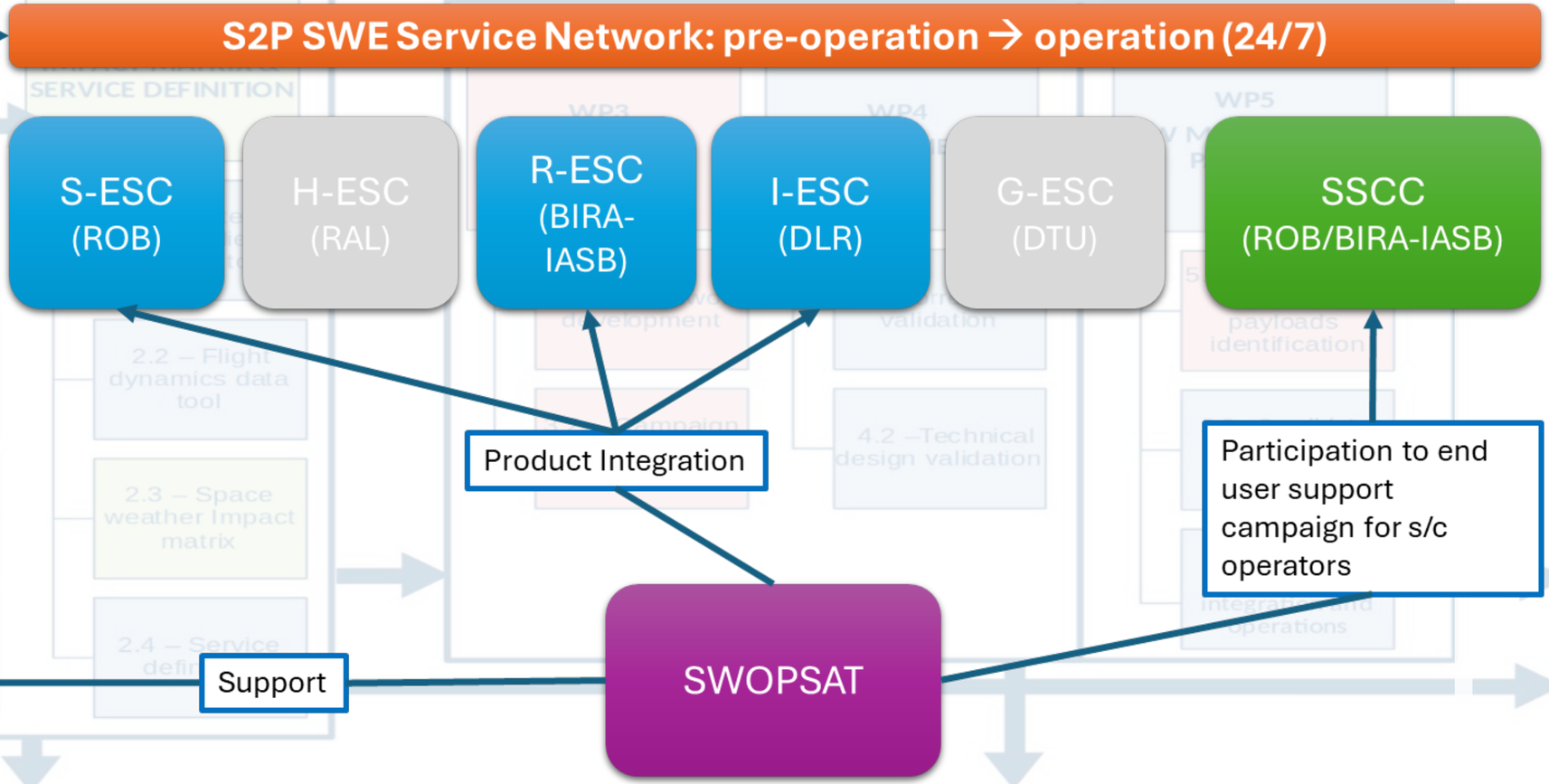


5 key points:

- Identify space weather causes of LEO satellite anomalies
- Define operational space weather service towards LEO satellite operators (other orbits possible)
- Provide prototype service execution, interaction with the end users and evaluation of its success
- Data set gap analysis and (optionally) operations of a corresponding payload in orbit
- Sustainability plan and cost/benefits analysis for a future MoD satellite operator to consider


PROJECT MANAGEMENT, COORDINATION AND REPORTING (WP6)
WP6: Task 6.1 – Coordination
WP6: Task 6.2 – Final report
PROJECT PHASE 1
WP1
SoA & USER REQUIREMENTS
1.1 – Space weather SoA
1.2 – Satellite design and anomalies
1.3 – Preliminary match events & anomalies
1.4 _ Initial user requirements
WP2
IMPACT MATRIX & SERVICE DEFINITION
2.1 – Satellite anomalies logging tool
2.2 – Flight dynamics data tool
2.3 – Space weather Impact matrix
2.4 – Service definition
PROJECT PHASE 2
PROJECT PHASE 2.1
WP3
PROTOTYPE
3.1 – Framework development
3.2 – Campaign & lessons learned
WP4
ASSESSMENT
4.1 –Correctness validation
4.2 –Technical design validation
PROJECT PHASE 2.1
WP5
SW MONITORING PAYLOAD
5.1 - Data gap & candidate payloads identification
5.2 - Candidate mission identification
OPTIONAL
5.3 - Payload integration and operations
DATA MANAGEMENT
WP7
DATA MANAGEMENT
7.1 – Collection & storage of data
7.2 –Data management strategy
VALORIZATION, DISSEMINATION, AND COMMUNICATION STRATEGY (WP8)
WP8: Task 8.1 – Dissemination & communication strategy
WP8: Task 8.2- Educational material & courses
Lead by ROB
Lead by ASL
Lead by BISA
Lead by RMI

How does SWOPSAT relate to ESA Space Safety Program?



What worked well?

Overall Evaluation:



- First ever Belgian prototype for 24/7 space weather service support to satellite operators
- Interesting
- Useful & Timely



AIR AND SPACE Published May 11, 2024 10:33am EDT

Huge solar storm impacting Starlink satellites, 'degraded service' reported: Musk

Musk warned early Saturday that Starlink satellites were under a lot of pressure as the powerful storm crashes into Earth

By Michael Dorgan | FOXBusiness

U.S. Stock Market Quotes

Quotes displayed in real-time

Quote Lookup

DOW JONES AVERAGES (I:DJI)

38,589.16

-57.94 (-0.15%)

NASDAQ COMPOSITE INDEX (I:COMP)

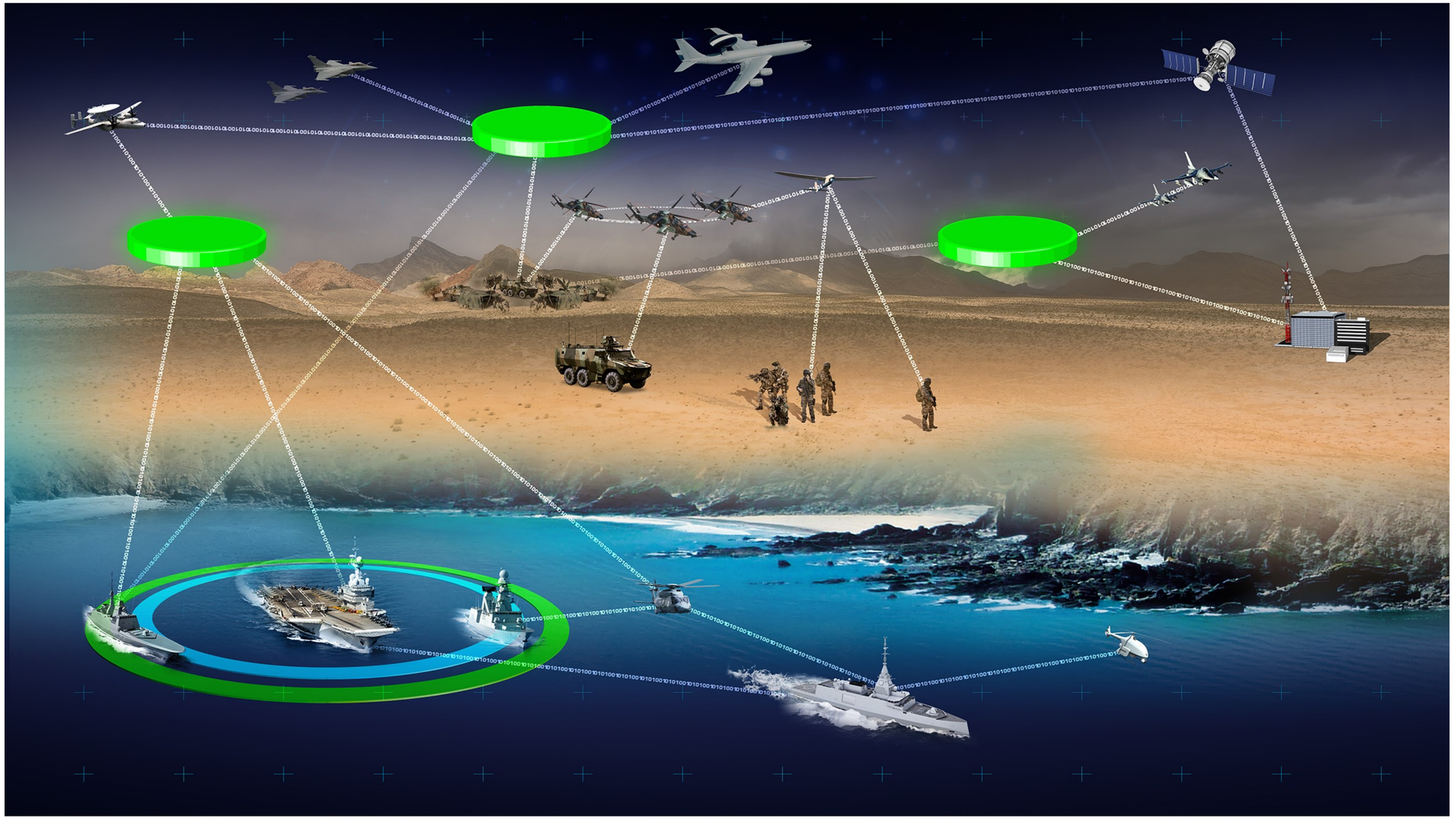
17,688.88

21.32 (+0.12%)

S&P 500 (SP500)

5,431.60

What was missing?







- **Question 6: Why are there no military partners in this project, and how does the team plan to engage with them in order to ensure a useful output for them?**

The STAR plan outlines a clear space ambition of the Belgian MoD. SWOPSAT is timely to start proto-typing and evaluating the required space weather service for a Belgian military presence in LEO.

It is our understanding that for now, that no military satellite operator unit currently exists. Therefore WP8 (Valorization, Dissemination, and Exploitation) includes significant efforts to reach out to military stakeholders and identifying specific needs. Our expectation is that a B-MoD military POC will be swiftly identified and/or assigned after selection.

It is to be noted that for aviation space weather services, the STCE already has a long-term, successful collaboration with the MeteoWing service.

In any case, the outcome of the project is aimed to be used by the Belgian Defense in future decision making on the desired level of engagement in the space defense sector.

FUTURE OPPORTUNITIES?



STCE

DEFENSIE
LA DÉFENSE

belspo

ROYAL OBSERVATORY
OF BELGIUM

BIRA•IASB

RMI

DEFRA
DEFENCE-RELATED RESEARCH ACTION

THANK YOU!

yana.maneva@oma.be

