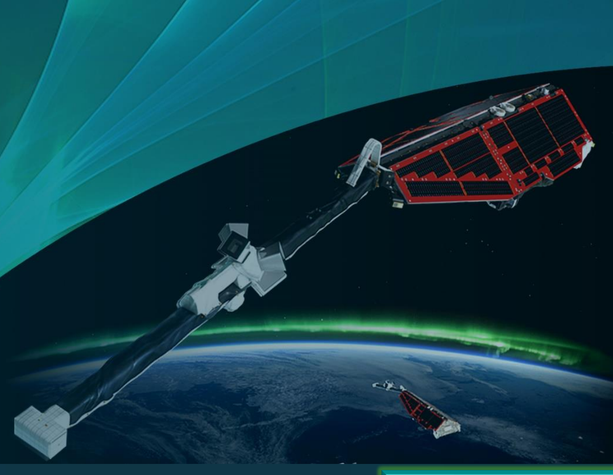
Swarm Mission status and future prospectives

Anja Strømme and Enkelejda Qamili

On behalf of the whole Swarm team



Swarm Mission Status

The three satellite Swarm constellation is on a mission to unravel our planet's invisible shield - the Earth's magnetic field, and Swarm is, after 10 years in orbit, still in excellent shape and is still contributing to a wide range of scientific studies from the core of our planet via the mantle, the lithosphere and out to the ionosphere and the interaction with the Solar wind.

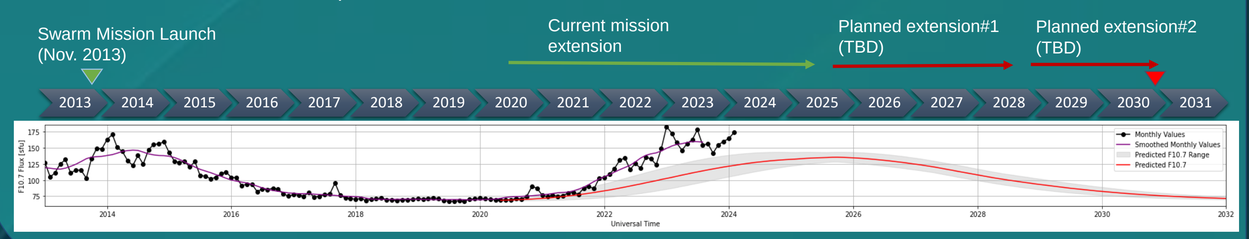
Excellent performance overall

- Platforms, instruments and ground segment nominal and in overall good health
- Full mission reprocessing and TTO of new baseline completed
- New "Fast" data chain developed, and TTO performed in Nov. 2023
- Improved data access and discoverability
- No major concerns regarding life-limited items including fuel reserves on all three spacecrafts - both in the 2025 (and 2030 timeframe)

Swarm Mission Lifetime

The Swarm mission has been extended several times in the past through a scientific assessment performed by ACEO (ESAC) followed by PB-EO approval. A new procedure ESA/PB-EO(2020)40 is in place to align the mission extension with the 3 year cycle of the FutureEO program in time for the Ministerial Conferences.

Swarm is currently extended through 2025, and if onboard recourses and funding allows, the plan is to fly the mission through the current solar cycle and deorbit during next solar minimum (~2030) to allow lithospheric measurements close to Earth while the Sun is quiet.



Swarm Mission Objectives

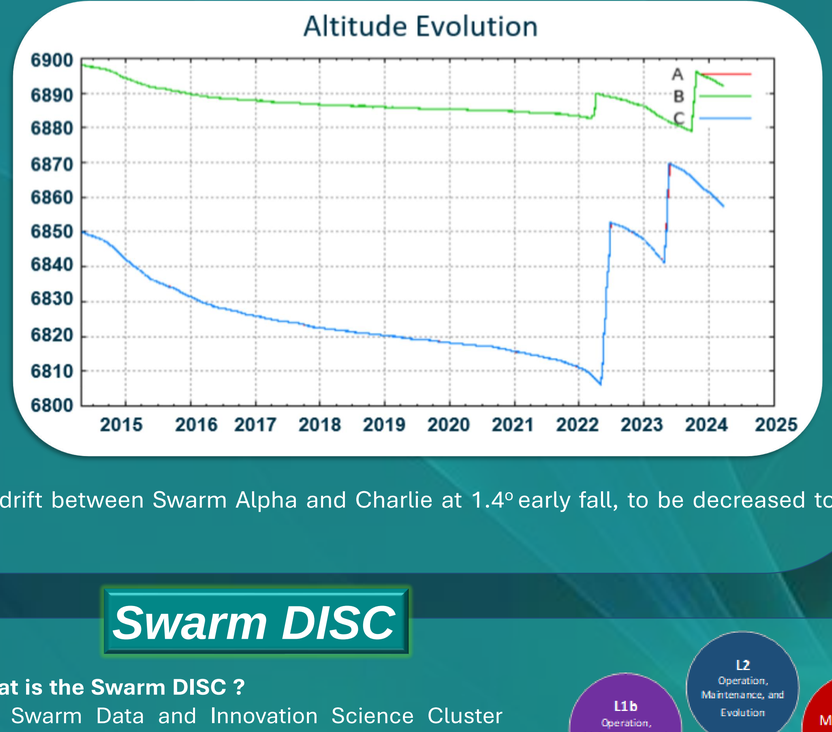
- Capturing and understanding the Earth's core dynamics
- Mapping and understanding the near-Earth environment response to the solar cycle
- Distinguishing spatial and temporal variation in the near-Earth environment
- Mapping ocean tides and the electrical conductivity of the mantle
- Versatile opportunities at the cutting edge of Earth and space physics and the understanding of physics of solar-terrestrial coupling
- Lithospheric Magnetic Fields

Swarm Orbit Evolution

Due to the very active phase of the Solar cycle the lower pair (Swarm Alpha and Charlie) are sinking, currently with a rate of 2 km/month. To prevent an early re-entry a series of orbital manoeuvres to raise their orbits has been performed.

This orbital raise was carried out in few steps, i.e., raising the altitude of Swarm Alpha and Charlie by about 45 km in May 2022 and raising it again by 29 km in April 2023.

To ensure the vertical separation between Swarm Bravo and the lower pair, the altitude of Swarm Bravo was raised by ~19 km in September 2023.



In addition, we stopped the relative drift between Swarm Alpha and Charlie at 1.4° early fall, to be decreased to ~1.2° toward the end of the mission

Swarm Product Portfolio

L1B AND L2 Data

Multi-scale Magnetic Field variations from the core to the ionosphere

- Production on L1B MAGNET, PLASMA, ORBIT and ATTITUDE data: **NOMINAL**
- Production of L2 data : **NOMINAL** / growing portfolio of **~40 products.**
- **Completed** | new L1B baseline, **reprocessing & TTO** deployed on end Q3-2022.

L3 & MULTI-MISSIONS

Synergy with other satellite missions that enhance the scientific return of Swarm

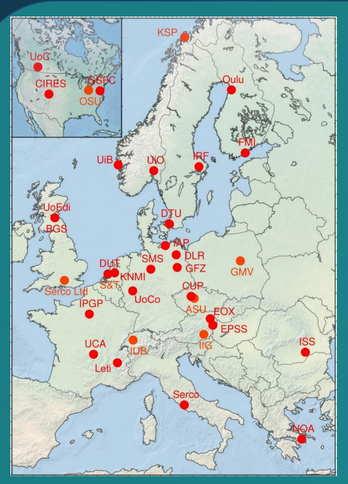
- **On-going** | Calibrated platform Magnet data from GOCE, GRACE, GRACE-FO and CryoSat-2
- **On-going** | MSS-1, CSES and E-POP data processed, formatted & calibrated *a la Swarm*.

FUTURE SPACE WEATHER

Fast-track processing of selected L1b and L2 data for Space Weather applications

- **Top priority** during Swarm Mission extension phase
- **Completed** | Implement, test, and operate FAST processing of multiple L1B Swarm data products
- **On-going** | 3 DISC projects for Space weather product & services + 4 newly kicked-off R&D projects
- **On-going**| Implement, test, and operate FAST processing of multiple L2 and L3 Swarm data products and indexes

Swarm DISC

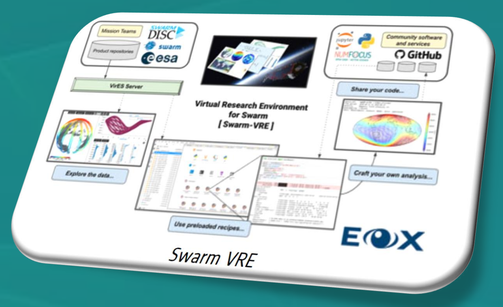


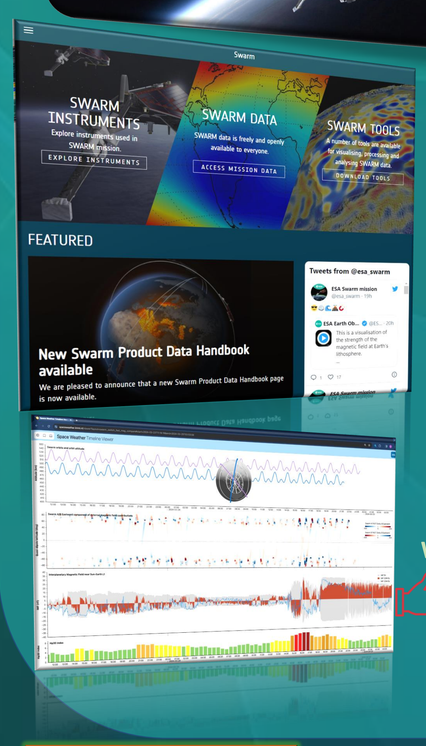
What is the Swarm DISC ?
The Swarm Data and Innovation Science Cluster (DISC) is an international consortium created to enhance the scientific return of the Swarm mission.

Main Tasks
Process & disseminate Swarm data, communication, identify, select and run New Swarm Products and Services.

Swarm DISC Consortium
The Swarm DISC Consortium currently consist of 35 partners from 19 countries in Europe and North America

Swarm Data Access





All Swarm Level 1B (OPER &FAST) and Level 2 (OPER) data are freely accessible to all users :

http://swarm-diss.eo.esa.int

ftp://swarm-diss.eo.esa.int

Interactive data manipulation tool & retrieval for Swarm

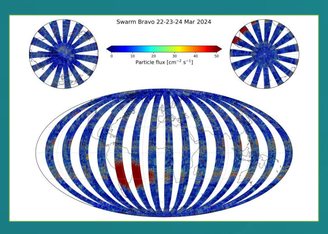
https://vires.services

https://spaceweather.knmi.nl/viewer

Web-based interactive environment based on JupyterLab:

https://viresclient.readthedocs.io

Status of Swarm L1B OPER and FAST data

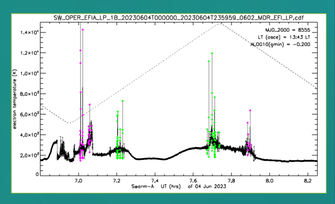


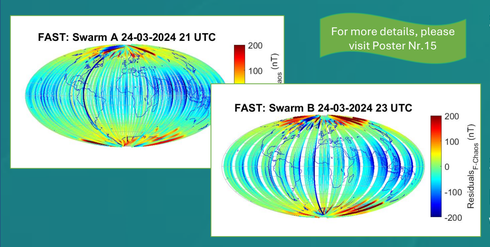
Overall status of Swarm OPER L1B data is Nominal

For more details, please visit Poster Nr.9

Evolutions to be implemented in Swarm L1B Operational data production chain (Q4/2024), e.g.,

- *STR particle counter product: new product containing the high energy proton flux (>100 MeV) measured by the Camera Head Units by counting the hotspots*
- *Improved dB_Sun correction for ASM data to count for Sun eclipse*
- *new computation for electron density and improved flagging for artificial spikes*



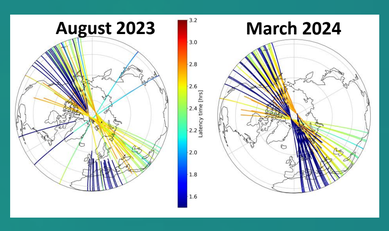


For more details, please visit Poster Nr.15

Status of Swarm FAST L1B data is Nominal

- *A downlink optimisation strategy to reduce the latency of Swarm FAST data acquired over Northern Europe was implemented on 11 March 2024.*

Soon all evolutions planned for the OPER data production chain will be implemented on FAST as well.



Upcoming events

You are invited to attend the Swarm Data Quality Workshop 2024 (DQW#14)

When: 7 to 11 October 2024

Where: Bucharest, Romania

SWARM 10 YEAR ANNIVERSARY SCIENCE CONFERENCE

08–12 April 2024 | Copenhagen, Denmark