Big Data Foundations for Earth Observation - Scouts and Direction of New ESA Missions

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What are Scouts?

Scout framework

- New category of research missions in Earth Observation since 2019, inspired by New Space
  - **science-driven**: prove new disruptive concepts and timely deliver **innovative** science
  - not in-orbit demonstrator, not commercially-driven
  - **short turnaround** (3 years), **small budget** for implementation (35 M€ e.c. 2024)
- ESA pulls the science innovation, using its many years of expertise
  - Identification of technologies to be further matured for science
  - ESA brings its technical expertise on key technological areas as needed
- Higher level of risks accepted
- Industry builds on the New Space paradigm to implement
  - Use of COTS + industrial know-how and processes
- Key steps:
  - **Bottom-up** approach to define a mission concept → **consolidation phase**
  - **Top-down** approach to deliver innovative science as a service → **implementation phase**

→ Scout framework: quick innovative science + NewSpace

Step 1: Consolidation phase

- Objectives:
  - **identify new potential Scout candidate missions** (up to 4)
  - **prepare each candidate for implementation within cost and schedule**
    - consolidate the mission concept and the baseline system architecture
    - consolidate the mission requirements, perform the preliminary flow-down to system requirements
      → **demonstrate the feasibility of the system to deliver science**
    - consolidate an end-to-end mission performance simulator
    - ad hoc developments to ensure readiness of critical technologies
    - consolidate the overall development approach
- Budget: 700 k€ e.c. 2024 for each candidate mission, 9 months

→ **Down-selection** of 2 missions for implementation based on

- Independent scientific assessment (with ranking)
- programmatic assessment

Step 2: Implementation phase

- Boundary conditions
  - a **low-cost approach** (35 M€ e.c. 2024 for the phase B/C/D/E1)
  - a **rapid development cycle** (3 years)
- More **pro-active role of industry** (→ service contract with limited oversight from ESA)
- Fully funded **end-to-end service contract**
  - Contractor → procure, develop, validate, launch, operate and complete the entire system (ground segment, space segment, launch services and operations)
  - Key Performance Gate Reviews (KPGR) foreseen at key stages → to raise confidence that the service will be delivered as expected.
- Which service?
  - **delivery of innovative science products** (up to Level 2)
  - specified in the Mission Requirements Document (MRD), proposed by industry, countersigned by ESA and the Science Advisory Group at kick-off
  - free and open data policy

Very lean approach

- **Lean** ESA project team
  - Very flexible, solution-oriented mindset → constant adaptation to actual progress
  - Few experts involved in ESA → focus on specific critical areas
  - Foster cooperation and transparency with industry → “same boat approach”
- **Lean** reviews
  - Project-level reviews only (no independent reviewers)
- **Lean** documentation
  - Solely driven by industry needs

    → no additional document for the sole benefit of ESA
- **Lean** standards
  - ESA proposes a thorough tailoring to fit within the Scout framework and the New Space approach
  - Industry invited to further tailor, using proven industrial expertise and know-how

  → alignment of expectations at the very beginning

Opportunities for commercialisation

- **Scaling-up**
  - It is easy to add recurring satellites to a Scout mission at a low-cost (not to be paid by ESA)
    - to replace satellites nearing end-of-life
    - to improve the science return once the concept is demonstrated
      (e.g. improve coverage or reduce revisit time)
    - to **expand the science products to commercial applications** (e.g. Green transition and sustainability regulations)
- **Commercial applications**, though not at the heart of the selection of Scout missions, are relevant
  - To address commercial needs which can be built on the science service
  - An **incremental approach (Minimum Viable Product)** is very suitable:
    - Start with “basic” commercial service directly derived from the science products
    - Add one recurring satellite to expand the commercial service
    - Then add more recurring satellites as the commercial service further grows

  → Financial risks can be minimized

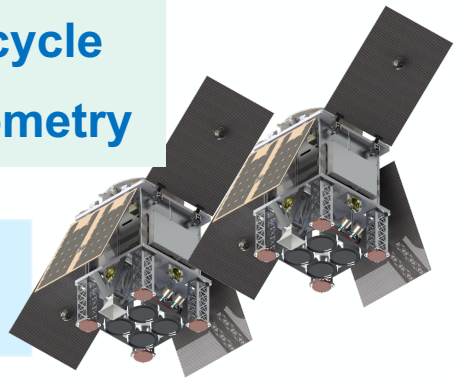
The Scout family at a glance

The current family

SSTL

Earth water cycle

GNSS reflectometry

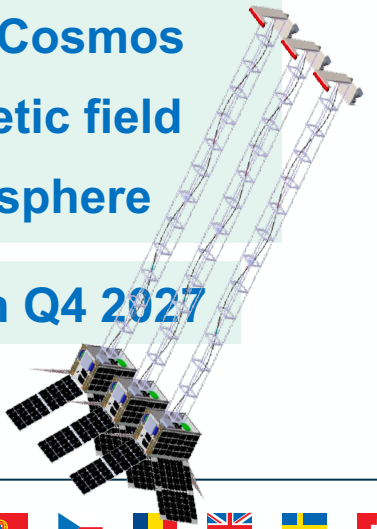


Launch
Nov 25

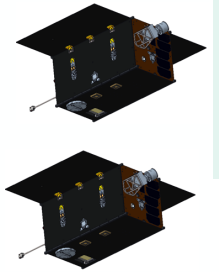
Open Cosmos

Magnetic field

Ionosphere



Launch Q4 2027



ISISpace

Pollutants from large industrial sites

Launch Q3 2028

More Scout missions to come soon

- **April 2025**: **down-selection of 4 new mission candidates**
  - **HiBiDiS** (Hyperspectral Biodiversity Scout Mission), led by Sitael (Italy)
  - **NAIAD** (Near-coast And Inland Aquatic impact Data), led by SSTL (UK)
  - **SIRIUS** (Space Based Infrared Imager for Urban Sustainability), led by TAS (Spain)
  - **SOVA-S**, led by OHB (Czech Republic)

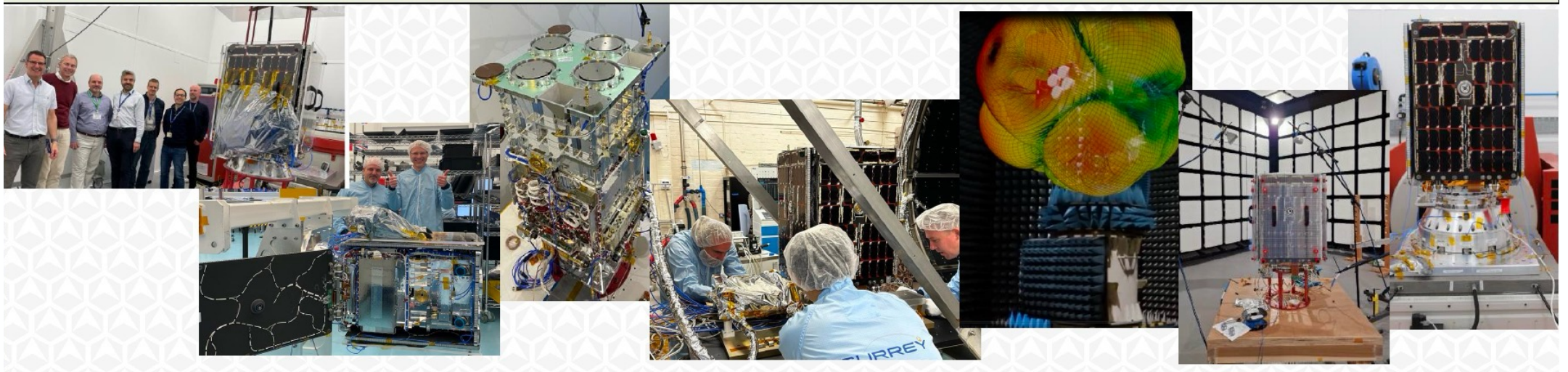
- January 2026: completion of the consolidation studies (9 months)
- February – March 2026: independent scientific assessment and ranking
- May – June 2026: **Selection of up to 2 new Scout missions for implementation**

- July – December 2026 (6 months): proposal preparation, submission, evaluation, negotiations
- **January 2027**: **Implementation phase kick-off**
- **January 2030**: Final Acceptance Review (KO + 3 years)

HydroGNSS, the first Scout to be launched

HydroGNSS: Environmental test campaign

PFM: Vega-C Vibe -> destack/rebuild/Thermal -> TVAC -> F9 changes -> Antenna pattern -> EMC -> F9 Vibe



FM2: F9 Vibe ----------> Thermal -> TVAC -> F9 changes ----------> Antenna pattern --> EMC

Credits: SSTL

HydroGNSS: good memories

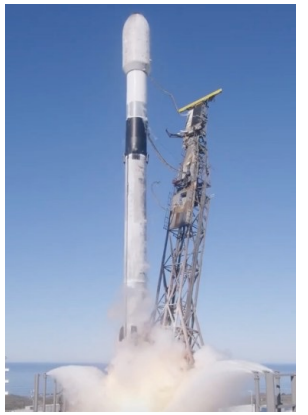
HydroGNSS: last mile till launch

- June 2025:
  - Successful completion of the environmental test campaign for both satellites
- July 2025: successful Final Acceptance Review
- September 2025: shipment to SpaceX facilities

- **10th – 30th November 2025: launch**

- May 2026: In-Orbit Commissioning Review (launch + 6 months)

Godspeed HydroGNSS!



Conclusion

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- Scout framework:
  - blending **New Space** & ESA EO science mission expertise
  - more proactive role given to Industry, lean approach with limited oversight from ESA
  - quick turnaround, small budget while **delivering valuable and innovative science as a service**
  - offers **key opportunities** for Industry in Europe, including commercialisation
    - Commercial applications can be incrementally derived from the science products at a low cost
      - → minimise risks as initial development is fully funded and supported by ESA experts
      - → maximise return on investment

- Scout family expands very quickly:
  - HydroGNSS: first Scout mission, to be launched very soon (Nov 2025)
  - Other 2 current missions being implemented: NanoMagSat and TANGO, both on track
  - And 2 more to join the family next year!

Visit https://www.esa.int/Applications/Observing_the_Earth/FutureEO/Scouts_ESA_s_agile_research_missions

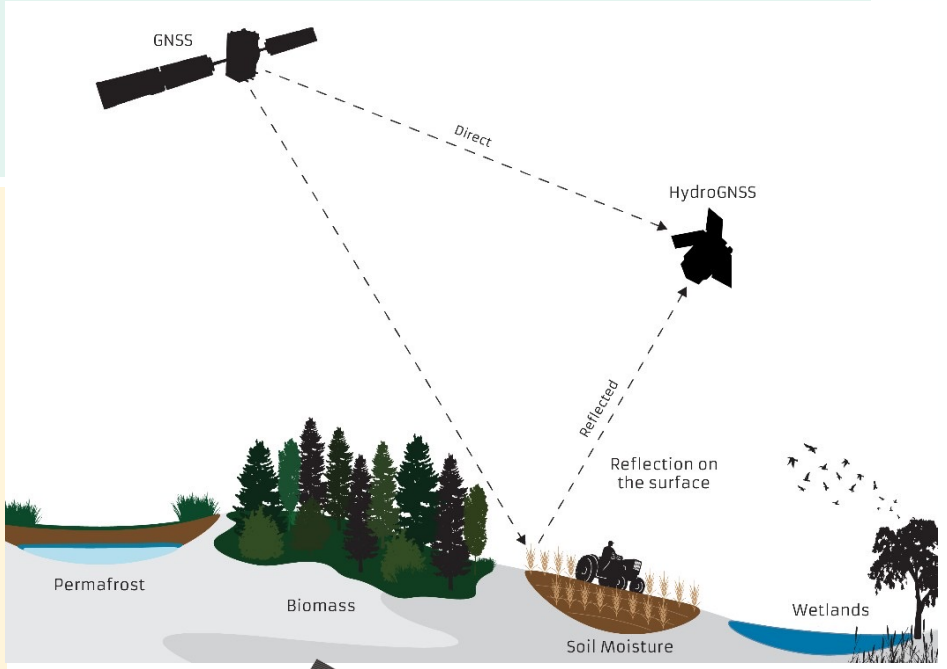
Thank you for your attention

Backup slides

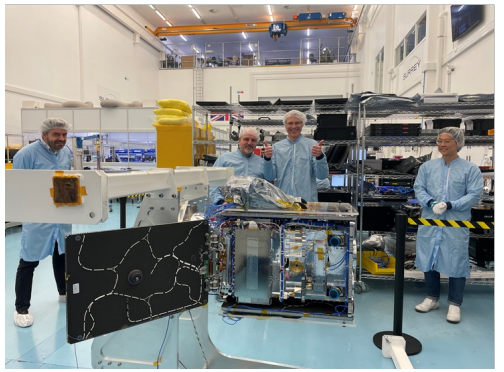
HydroGNSS

- Industrial team: **SSTL**, Sapienza University, IEEC, FMI, NOC, NGI, IFAR-CNR, Tor Vergata, TU Wien
- Aim: **improve our knowledge of the Earth water cycle**
- Technique: **GNSS reflectometry**

- Constellation of two small satellites
- Sun synchronous orbit, ~550 km altitude
- Launch: Nov 2025
- Service (science data) for up to 4.5 years
  - soil moisture, inundation / wetlands
  - soil freeze / thaw (notably over permafrost)
  - above-ground biomass
- **Innovations:** new signals never acquired before
  - dual-polarization
  - dual frequency
  - coherent and incoherent channels



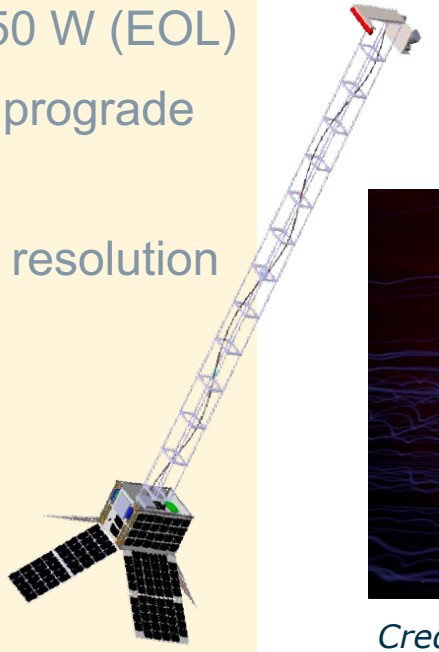
Credit: SSTL

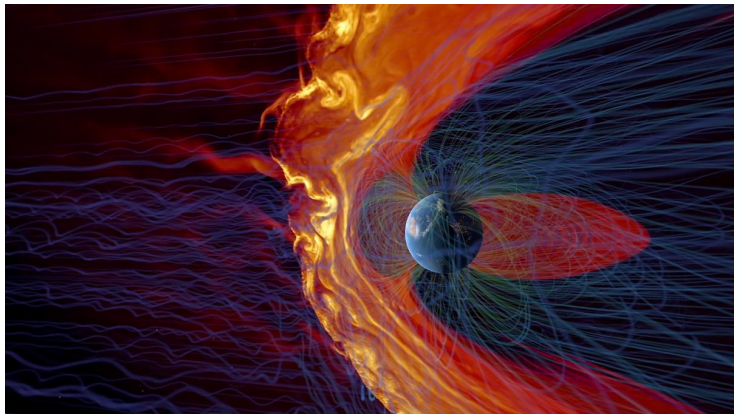


NanoMagSat (Scout-3)

- Industrial consortium: Open Cosmos (Prime Contractor), CEA-Léti, University of Oslo, COMET, DTU, IPGP
- measure the Earth's Magnetic field & the ionospheric environment
- maintain the European leadership in Earth magnetic field monitoring (monitored from space since 1999)
- provide crucial scientific data with applications in many fields: geophysics (Earth core), space weather hazard assessment, precise navigation, reference models used in smartphones, directional drilling for oil and gas
- improve temporal resolution (factor 4) thanks to a constellation sampling at all local times (faster than Swarm)

- 3 x 16U satellites at ~550 km altitude, mass ~32 kg, power ~50 W (EOL)
- 2 satellites at 60 deg inclination (90 deg offset in RAAN), 1 in prograde polar orbit (→ Swarm-B)
- Innovation: state-of-the-art compact payload, higher temporal resolution
  - 1 Miniaturised Absolute Magnetometer
  - 1 High Frequency Magnetometer (2 kHz)
  - 1 multi-Needle Langmuir Probe
  - 2 dual-frequency GNSS receivers
- Implementation kick-off in Q4 2024, launch in Q4 2027

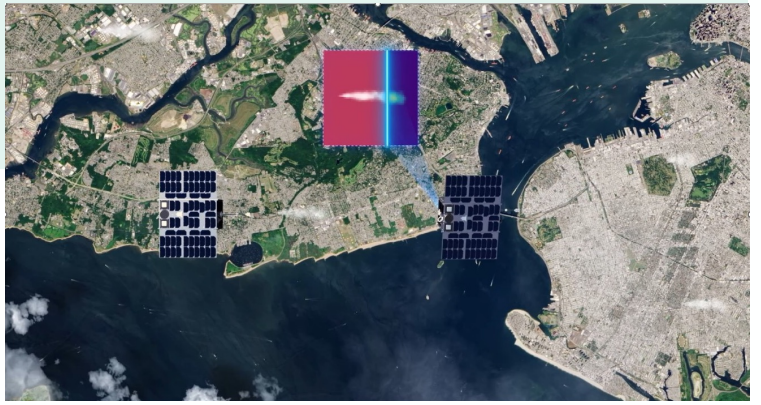




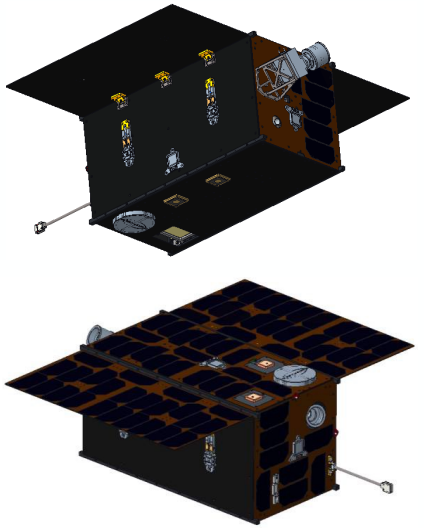
Credit: Open Cosmos

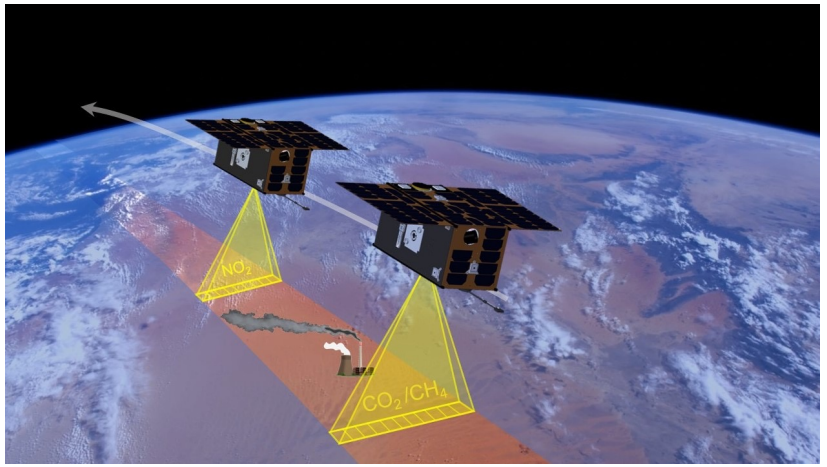
TANGO

- industrial consortium: **ISISpace** (Prime Contractor), TNO, KNMI, SRON
- **measure and monitor CH_4, CO_2 and NO_2 emitted by large industrial sites**
- complement Copernicus Sentinel-5P mission and CO2M mission
- help verify the Paris Agreement



- 2 16U satellites in a tandem: Carbon & Nitro
- payload: imaging spectrometer
  - reflective push broom
  - TANGO-Carbon: SWIR1 spectral band
  - TANGO-Nitro: visible spectral range
- roll and pitch agility
- forward motion compensation
- **Innovation**: tandem measurements, plume estimation
- Implementation kick-off Q3 2025, launch Q3 2028





Credit: ISISpace