ASI current and future Earth Observation Missions: an overview

Giovanni Rum, Francesco Longo
Agenzia Spaziale Italiana
Earth science and applications
Ensure that Earth Observation missions offers the best possible benefits for science and society. Involve EO community in all program phases.

Sustain development of new instruments
Radiometers, Quantum Gravimetry, etc...

Achieve autonomy in HR systems
Miniaturized HR Payload and Technology Roadmap

Secure the leadership in Hyperspectral payload
Hyperspectral Next Generation, Miniaturized Payload and Technology Roadmap

Sustain the Future of Synthetic Aperture Radar
New SAR instruments and constellations (X/I/P Bands) and Technology Roadmap

Consolidating the Lidar capability
Lidar mission and Technology Roadmap

Strengthen developments in Thermal Infrared
ASI-NASA TIR mission, Miniaturized Payload and Technology Roadmap

Pull users towards applications and services
Facilitate access to data, information and processing capabilities. Pioneer new services. Stimulate downstream industrial and economic growth

Earth Observation at glance: 8 major objectives
Microwave: COSMO-SkyMed and Beyond

**SPOTLIGHT**
- **CSK**
  - Very High Resolution (VHR) (sub-metric)
  - Governmental Use
  - Resolution: 1 m
  - Single Polarization
  - Size: 10 km x 10 km
  - Civilian and Defence use

**STRIPMAP**
- Resolution: 3 m
- Single Polarization
- Swath Size: 40 km
- Civilian and Defence use

**SCANSAR**
- Resolution: 30 m
- Single Polarization
- Swath Size: 100 km
- Civilian and Defence use
- Resolution: 100 m
- Single Polarization
- Swath Size: 200 km
- Civilian and Defence use

**CSG**
- Ultra-High Resolution (UHR) (sub-metric)
- Governmental Use
- Spot-2
  - VHR and Dual Pol. (***)
  - Sp-2A res. ≤ 0.35 x 0.55 m
  - Swath ≥ 3.1 x 7.3 km
  - Sp-2B res. ≤ 0.63 x 0.63 m
  - Swath ≥ 10 x 10 km
  - Sp-2C res. ≤ 0.80 x 0.80 m
  - Swath ≥ 5 x 10 km
  - Civilian and Defence Use

**The FUTURE**
- New architectures: a system of systems
- GEO and LEO elements
- Multi-Sensor capabilities (X and L band SAR)
- Multi modes: mono and bi-static SAR
- Enhanced performances
- Systematic mapping and new on-demand services
2 Argentinian SAOCOM satellites (1A and 1B) with an L-Band SAR sensor onboard. Same orbit of COSMO-SkyMed satellites.

ASI has full utilization rights on its Area of Exclusivity AoE (approximately all the Europe territory).

Users:
- Scientific, institutional and commercial
- Italian and International
- only for non-commercial purposes

Access to data on ASI AoE:
1. Registration following the instruction at: [https://www.asi.it/en/earth-science/saocom/](https://www.asi.it/en/earth-science/saocom/)
COSMO-SkyMed - The 1st and the 2nd Generation

COSMO-SkyMed Second Generation (CSG) will:

- Ensure operational continuity to the currently operating constellation
- Achieve a step ahead in terms of functionality, performances and system services for the users

The 4 CSG Satellites will have an operational lifetime of at least 7 years. Evolutive approach already in place with FM3 & FM4

COSMO-SkyMed is the Italian end-to-end System for Earth Observation, funded by:

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PLATiNO-1 – SAR Mission-X band

Mission timeline:
- Commissioning (LEOP and Commissioning) 3 months;
- Phase-1 (@619 km, formation flying with CSK/CSG) 1 year;
- Re-orbit phase (orbit transfer) 6 months;
- Phase-2 (@410 km, monostatic acquisition) 1.5 years;
- De-orbiting phase 6 months.

During Phase-1 PLT-1 will mainly work as a receiver acquiring from Earth the signal generated by CSK/CSG

<table>
<thead>
<tr>
<th>Bistatic performances (Phase-1)</th>
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<tbody>
<tr>
<td>Altitude</td>
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<tr>
<td>Swath</td>
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<tr>
<td>Stripmap Resolution</td>
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<tr>
<td>Spotlight Resolution</td>
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<tr>
<td>Continuous stripmap</td>
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<table>
<thead>
<tr>
<th>Monostatic performances (Phase-2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude</td>
</tr>
<tr>
<td>Swath</td>
</tr>
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<td>Continuous stripmap</td>
</tr>
</tbody>
</table>

PLT-1 shall be sized to provide the capacity to acquire, downlink and archive images totaling **20000 km²** daily.

Launch date: end of 2024
THE REFLECTIVE/EMISSIVE BANDS: VIS-NIR-SWIR-TIR

Focus on:

- Multispectral imagery in the thermal IR.
- Hyperspectral imagery in the visible and shortwave infrared;
PRISMA - Hyperspectral

Fully funded by the Italian Space Agency (ASI): in-orbit Earth Observation system that simultaneously combines data of a hyperspectral sensor and a panchromatic camera from the same scene.

- 240 total bands in VNIR (#66, 400–1010 nm) & SWIR (#174, 920–2505 nm) at a spatial resolution of 30 m on a swath of 30 km
- Mean spectral resolution of 10 nm in a spectral range of 400-2500 nm
- Pan (Panchromatic) imagery is provided at a spatial resolution of 5 m
- Simultaneous acquisition of images in the VNIR, SWIR and PAN on the same scene
PRISMA 2nd Generation

PRISMA Second Generation is the future Hyperspectral Italian Mission.

- Entirely Funded by the Italian Space Agency
- High-performance satellite ensuring Hyperspectral data continuity currently available from the PRISMA mission and providing enhanced performances
- Launch date: end of 2027

- SWATH and SNR: on demand techniques of SWATH enlargement and SNR enhancement on a single pass using the platform agility.
  - Revisit time (72 h with a maximum off-nadir angle of ± 30°)

- Acquisition modes: STRIPMAP and SPOTLIGHT.
  - **STRIPMAP** image: VNIR/SWIR GSD ≤ 30 m and PAN GSD ≤ 5 m, swath ≥ 30 km and indefinite length with a Daily STRIPMAP Imaging Capacity (acquire, downlink and archive) more than 2.000.000 km2.
  - **SPOTLIGHT** image (on-demand): VNIR/SWIR GSD ≤ 10 m and PAN GSD ≤ 2.5 m, swath ≥ 30 km and length up to 210 km with a Daily SPOTLIGHT Imaging Capacity (acquire, downlink and archive) more than 200.000 km2.
MAIA will explore linkages between exposure to different types of PM and human health.

Products: Daily-averaged total PM$_{10}$, total PM$_{2.5}$, and speciated PM$_{2.5}$ mapped in selected areas on a 1-km grid.

Kicked-off a prototype project to assess population risk exposure at urban level, in the Southern Italian area, under a ASI-CNR/IIA Agreement. Planned extension to the other areas. Expected results also to support evaluation of SDG Indicator 16.2.1

Bounding box: 360 km x 480
The MAIA camera is mounted on a motorized gimbal that can rotate 60 degrees forward and backward as MAIA passes over a target on the Earth. This technique is called “step and stare.”

Launch date: by the end of 2025
MAIA Mission key components

Satellite instrument | Surface monitors | Chemical transport model | Health records

Public products

24-hr averaged concentrations of PM$_{10}$, PM$_{2.5}$, speciated PM$_{2.5}$

Epidemiological studies

Privacy protected

Birth, death, and hospitalization data

Sulfate | Nitrate | OC | EC | Dust
SBG-Surface Biology and Geology TIR-Multispectral Mission

SBG-VSWIR Wide-swath VSWIR Spectrometer

SBG-TIR Wide-swath TIR Imager

Launch date: end of 2027

**TIR instrument**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal IR Bands</td>
<td>8.28 µm / 8.63 µm / 9.07 µm / 11.33 µm / 12.05 µm</td>
</tr>
<tr>
<td>mid-IR bands</td>
<td>3.98 µm / 4.80 µm</td>
</tr>
<tr>
<td>short-wave IR</td>
<td>1.60 µm</td>
</tr>
<tr>
<td>NETD</td>
<td>0.2 °K @ 300 °K</td>
</tr>
<tr>
<td>GSD</td>
<td>60m</td>
</tr>
<tr>
<td>Swath width</td>
<td>935 km</td>
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<tr>
<td>Coverage</td>
<td>Global</td>
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**VNIR camera**

<table>
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<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Visible Bands center</td>
<td>655 nm</td>
</tr>
<tr>
<td>NIR Bands center</td>
<td>835 nm</td>
</tr>
<tr>
<td>SNR</td>
<td>100</td>
</tr>
<tr>
<td>GSD</td>
<td>&lt;35 m</td>
</tr>
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Launch date: end of 2027
**OCO-NEXT Mission**

**OCO-NEXT (The Next Generation Orbiting Carbon Observatory)** a ASI-JPL partnership to provide a key contribution to the understanding of carbon cycle behavior in an hotter world, with increasing number of extreme events

**What we expect from OCO-NEXT:**

- Extending the critical CO2 climate data record with global surface coverage and expanded capabilities compared to OCO-2 and OCO-3;
- Global, high-precision column mixing ratios of CO2, CH4, CO, and SIF, and gridded 250 km, monthly fluxes of CO2 and CH4;
- 150–180 km swath width with single sounding nadir footprint of 2 km × 2 km;
- Sun-sync, 833-km LEO orbit crossing at 1330 daily, flying in formation with JPSS-1/JPSS-2, near global coverage with 16-day repeat cycle.

**Instrument Complement:**

Measure CO2, CH4, CO, and SIF emissions simultaneously:

- **SIF instrument (ASI-contributed)**
  - Band 1 (677-697 nm): O2 B-band/Red SIF
  - Band 2: (740-780 nm): O2 A-band/enhanced SIF

- **GHG instrument (JPL)**
  - Band 3 (1591-1660 nm): weak CO2/CH4
  - Band 4 (2010-2085 nm): strong CO2
  - Band 5 (2302-2370 nm): strong CH4 and CO

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Electro Optical EO Instruments for Small satellites

- **Very High Resolution Camera:**
  - Native GSD: 0,5 m PAN and 2 m MS.
  - Swath: 8 km @400 km
  - Launch date: end of 2025

- **Compact Hyperspectral Camera, based on national heritage on PRISMA and CHIME:**
  - GSD @ 500 km: STRIPMAP = 30m,
  - SPOTLIGHT = 20 m, PAN = 5m
  - Swath: 20 Km

- **Thermal Infra-Red (TIR) Camera, an uncooled IR imager based on microbolometer detector:**
  - GSD @ 400 km: 40m
  - Swath: 40Km
  - Spectral central wavelength
    - (pre-flight tunable):
      - TIR1 8.6µm
      - TIR2 9.1µm
      - TIR3 10.3µm
      - TIR4 11.5µm
LIDAR mission: CALIGOLA
Cloud Aerosol Lidar for Global Scale Observations of the Ocean-Land-Atmosphere System

Mission Objectives

» Atmospheric particles and clouds microphysical and dimensional properties
» Aerosol type determination and Aerosol-cloud interaction processes
» Atmosphere and marine particles fluorescence measurement
» Earth's surface elevation measurements
» “Ocean color” products improvement & Characterization of organic matter/aerosols dissolved in the sea

Sub-System Technologies: Laser Transmitter, ultra-stable low-weight space telescopes, transmission/receiving optics,

Launch date: tentative 2030

Source: NASA/USGS, public domain
**MapItaly: A service for Italian institutional users**

**Ultimate Objective:** Provide a single access point to the SAR observations over Italy for institutional users

**Atmospheric particles and clouds microphysical and dimensional properties**

» Aerosol type determination and Aerosol-cloud interaction processes

» Since 2010, COSMO-SkyMed First (CSK) and Second Generation (CSG) are systematically mapping Italian Territory, X-band, stripmap mode, update of interferometric couples every 16 days.

» SAOCOM data (L-band) are being added systematically since 2022.

» Sentinel 1 data (C-band) will also be added (starting from 2014)

» Catalog and complete archive maintained online

» API for searching and downloading data

**Operational by the end of 2023**
THANK YOU FOR YOUR ATTENTION!