ASI current and future Earth Observation Missions: an overview

Giovanni Rum, Francesco Longo
Agenzia Spaziale Italiana

eurac research

Institute of Atmospheric Pollution Research
National Research Council of Italy

European Commission

Earth Observation at glance: 8 major objectives

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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

PRISMA

Secure the leadership in Hyperspectral payload

Hyperspectral Next Generation, Miniaturized Payload and Technology Roadmap

CSK

SAOCOM

CSG 1 & 2

CSG 3 & 4

Sustain the Future of Synthetic Aperture Radar

New SAR instruments and constellations (X/L/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

PLATiNO-3 VHR

V²HR

PSG

PLATiNO-4

MAIA

OCO-Next

PLATiNO-1 M&B

GEOSAR

COSMO FUTURO

L-Band M&B

CALIGOLA

SBG -TIR

Missioni in operazioni
Missioni in sviluppo
Missioni pianificate

NATIONAL/BILATERAL

PRISMA

SBG -TIR

PLATiNO-3 VHR

CSK

SAOCOM

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CSG

PLATINO-2
MAIA

PSG

L-Band M&B

PLATiNO-1 M&B

PLATiNO-4
Hyperspectral

GEOSAR

CALIGOLA
Lidar

NIR SWIR MWIR LWIR X C L

ESA / EC

AEOLUS

AEOLUS FO

FLEX

LSTM

CHIME

EarthCare

Forum

Sentinel-1

Harmony

Rose-L

BIOMASS

Microwave: COSMO-SkyMed and Beyond

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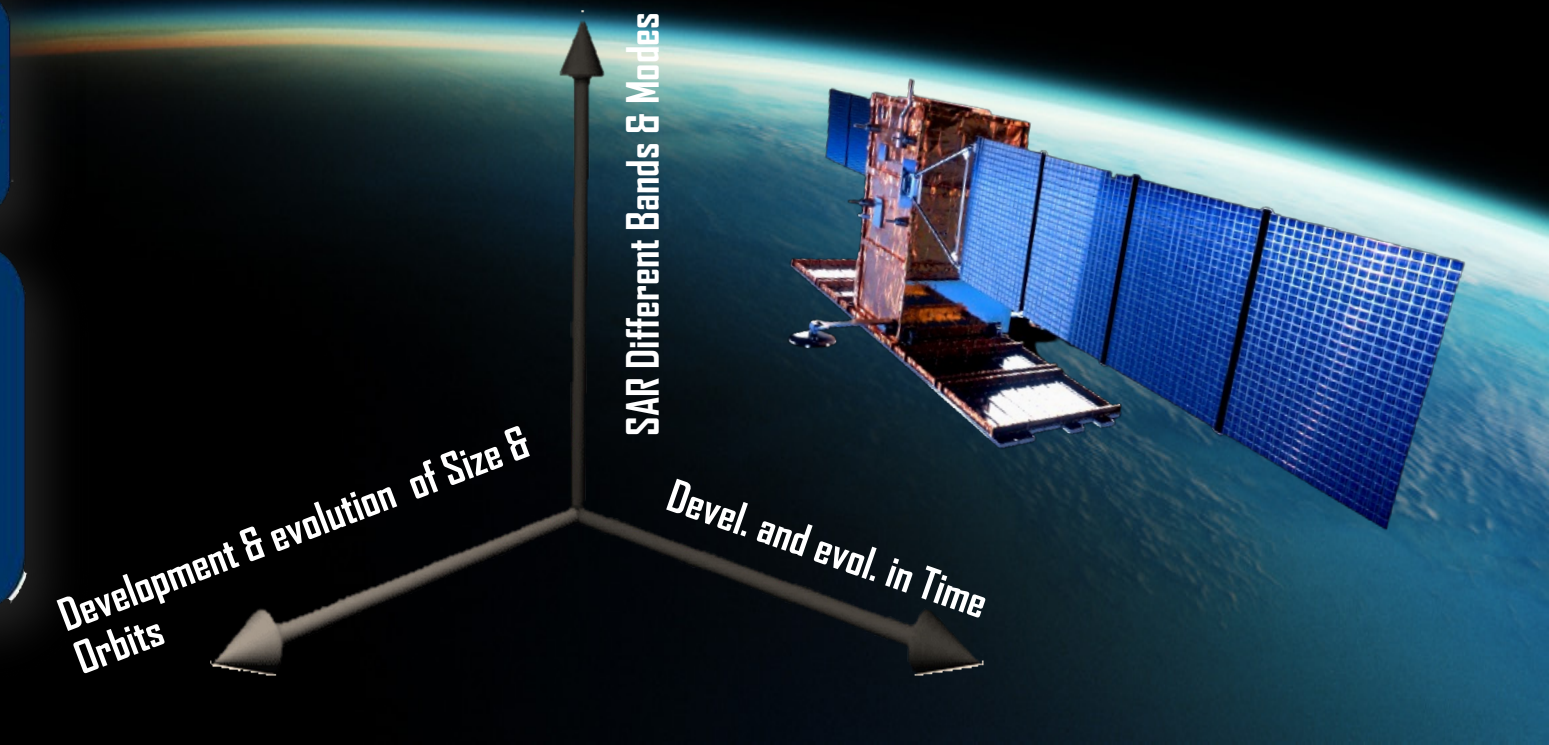
	CSK	CSG
SPOTLIGHT	Very High Resolution VHR *(sub-metric)* Governmental Use Resolution: 1 m Single Polarization Size 10 km x 10 km Civilian and Defence use	Ultra-High Resolution (UHR) Governmental Use Spot-2 *VHR and Dual Pol.* (**) Sp-2A res. ≤ 0.35 x 0.55 m Swath ≥ 3.1 x 7.3 Km Sp-2B res. ≤ 0.63 x 0.63 m Swath ≥ 10 x 10 Km Sp-2C res. ≤ 0.80 x 0.80 m Swath ≥ 5 x 10 Km Civilian and Defence Use
STRIPMAP	Resolution: 3 m Single Polarization Swath Size 40 km Civilian and Defence use	Resolution : 3m x 3m Swath Size Dual Pol 40 km Swath Size QUADPOL 15 km Civilian and Defence use
SCANSAR	Resolution: 30 m Single Polarization Swath Size: 100 km or Resolution : 100 m Single Polarization Swath Size: 200 Km Civilian and Defence use	Resolution : 4 x 20 m Double Polarization Swath Size : 100 km or Resolution : 6 x 40 m Double Polarization Swath Size: 200 Km Civilian and Defence use

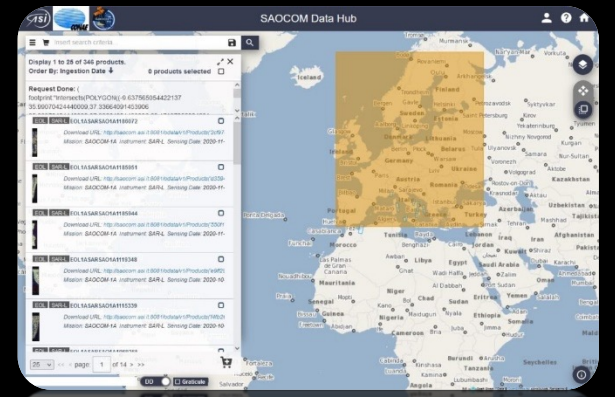
The FUTURE

- 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



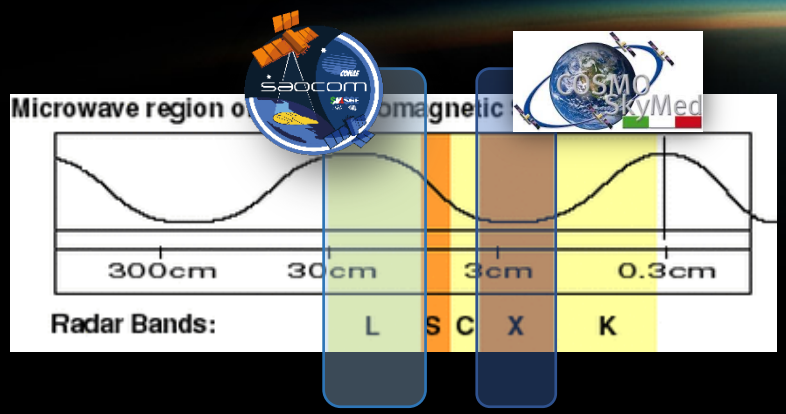
SAOCOM – in the frame of SIASGE

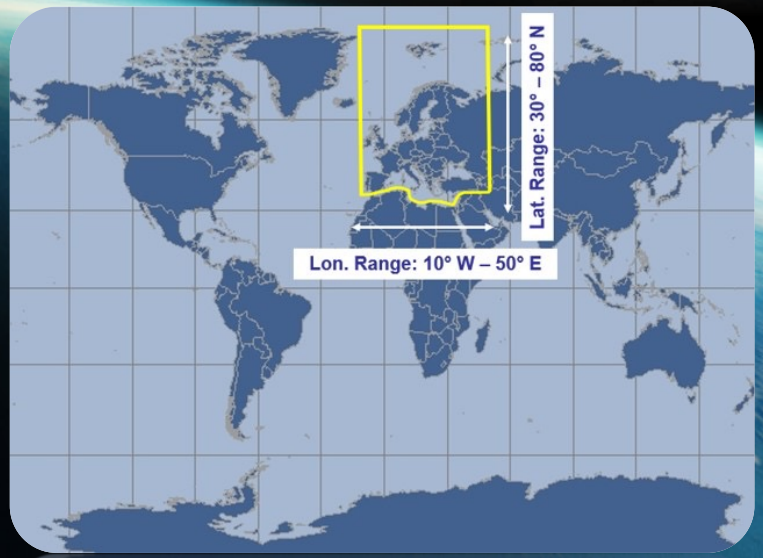
2 Argentinian SAOCOM satellites (1A and 1B) with an L-Band SAR sensor onboard. Same orbit of COSMO-SkyMed satellites.



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/
2. Access through the ASI SAOCOM Portal http://saocom.asi.it:8081

COSMO-SkyMed – The 1st and the 2nd Generation

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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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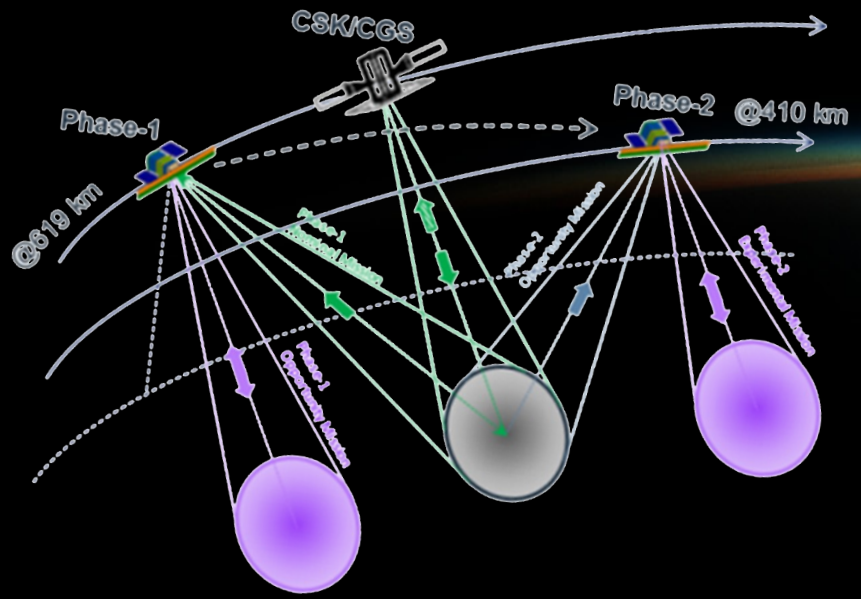
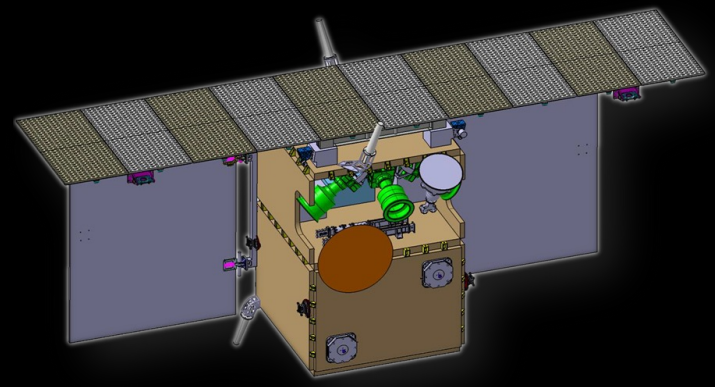
PLATiNO-1 – SAR Mission-X band

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.



PLT-1 shall be sized to provide the capacity to acquire, downlink and archive images totaling **20000 km2 daily**.
Launch date: end of 2024



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

Bistatic performances (Phase-1)	
Altitude	619 km
Swath	40 km
Stripmap Resolution	3 m
Spotlight Resolution	1 m
Continuous stripmap	Up to 1000 km

Monostatic performances (Phase -2)	
Altitude	410 km
Swath	15 km
Stripmap Resolution	3 m
Spotlight Resolution	1 m
Continuous stripmap	Up to 800km

THE REFLECTIVE/EMISSIVE BANDS:

VIS-NIR-SWIR-TIR

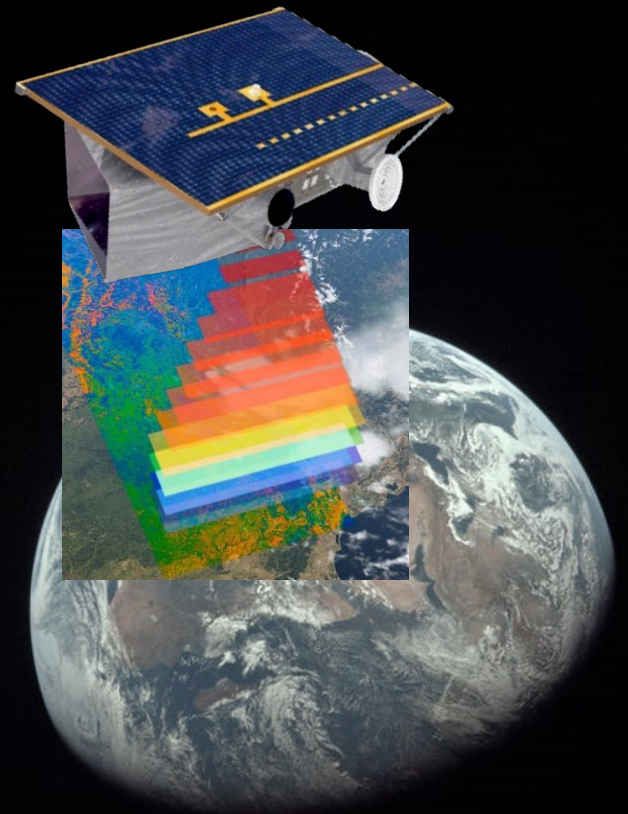
Focus on:

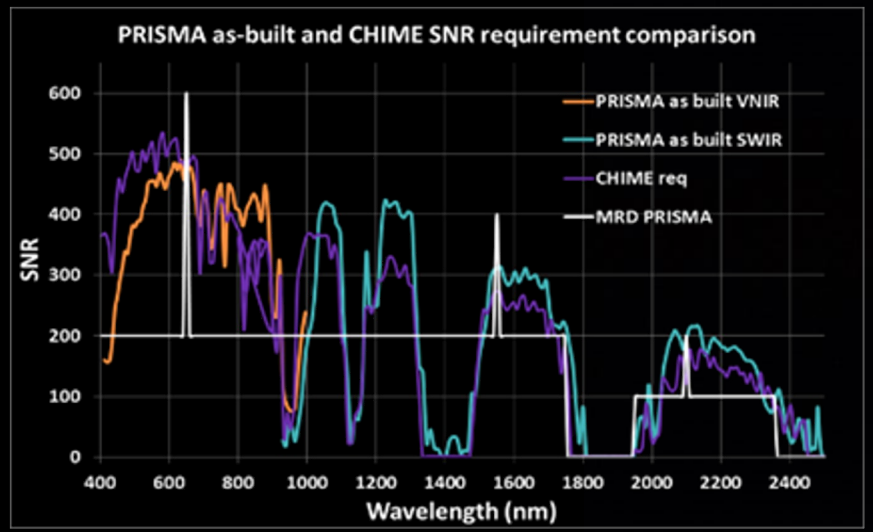
- Multispectral imagery in the thermal IR.
- Hyperspectral imagery in the visible and shortwave infrared;

PRISMA - Hyperspectral

Fully funded by the Italian Space Agency (ASI): in-orbit Earth Observation system that simultaneous 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

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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.

PLATINO-2 MAIA (Multi-Angle Imager for Aerosols)

NASA JPL Jet Propulsion Laboratory California Institute of Technology ASI Agenzia Spaziale Italiana

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.

Sulfate | Nitrate | OC | EC | Dust

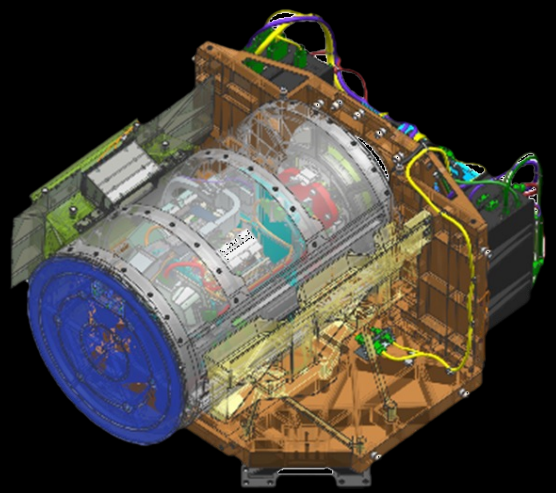
Kicked-off a prototype project to assess population risk exposure at urban level, in the Southern Italian area, under a ASI-CNR/IIA Agreement. Planned extension to the other areas. Expected results also to support evaluation of SDG Indicator 16.2.1

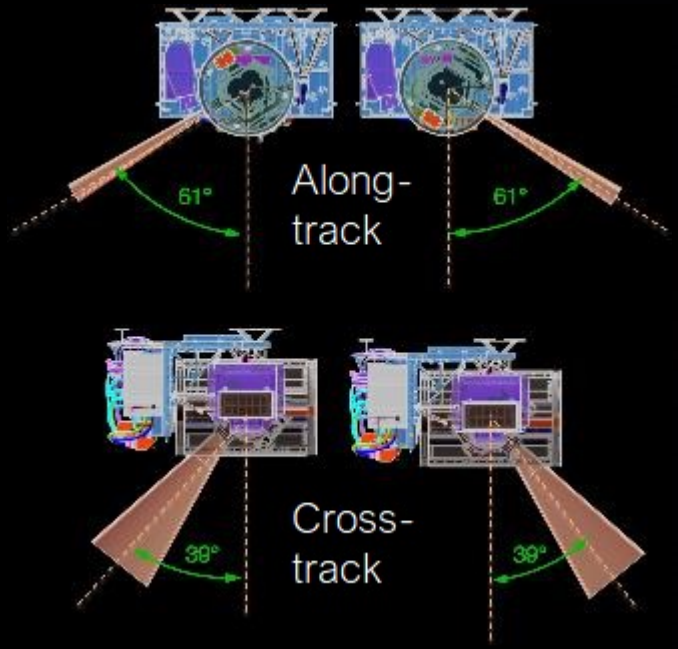
Observation areas over Europe

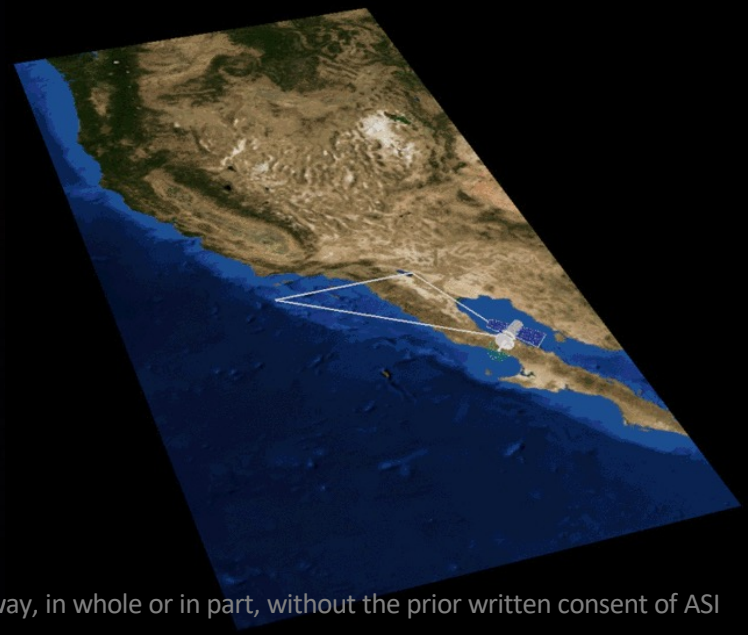
PLATiNO-2 – MAIA

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."

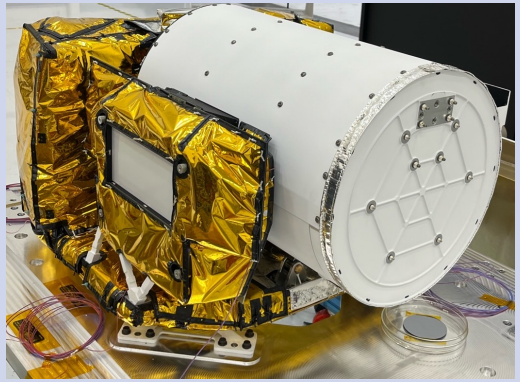
Launch date: by the end of 2025





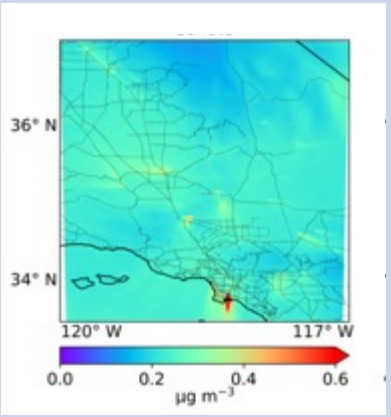


MAIA Mission key components



Satellite instrument

Surface monitors



Chemical transport model

Health records

Public products

Privacy protected

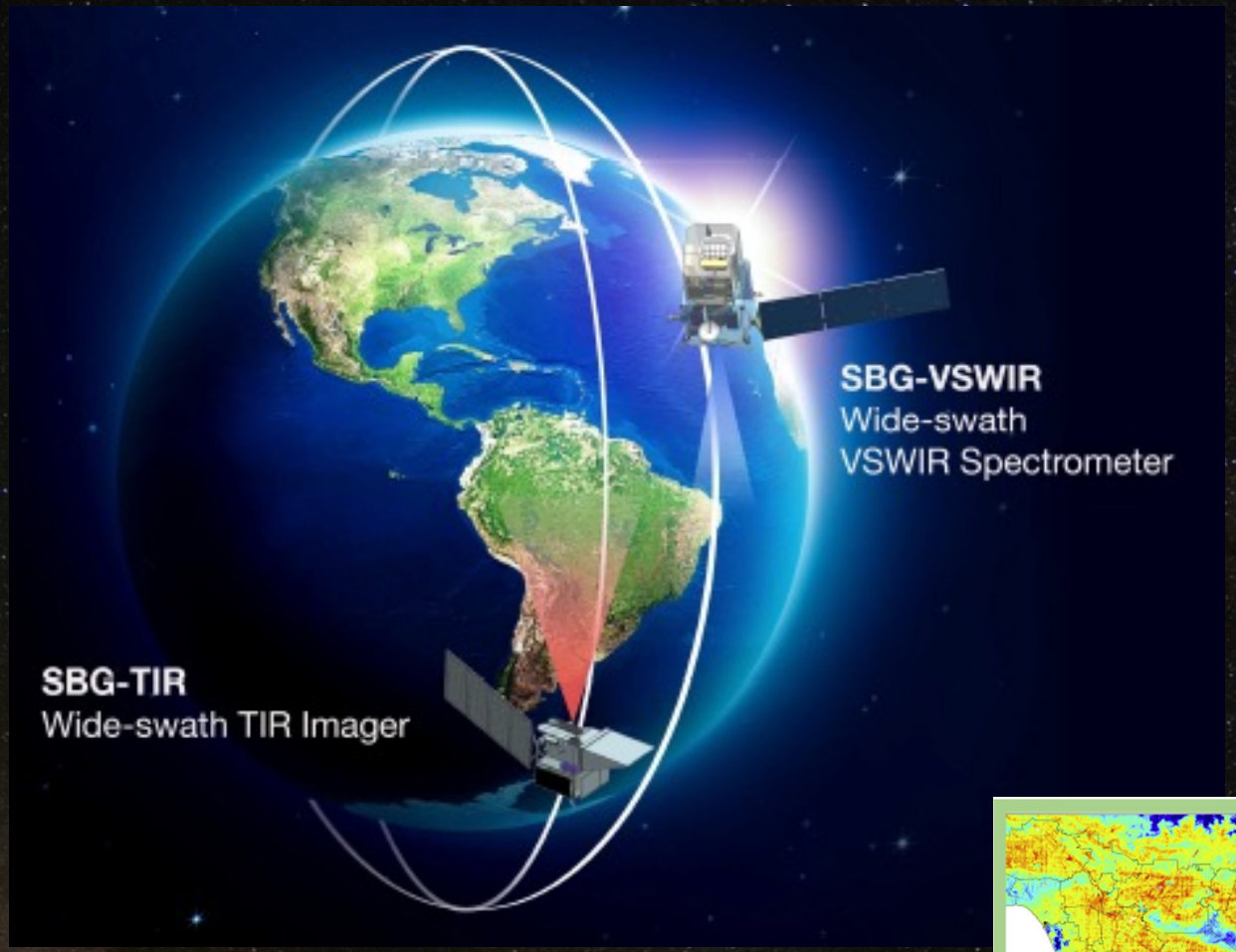
24-hr averaged concentrations of PM_{10}, $PM_{2.5}$, speciated $PM_{2.5}$

Sulfate | Nitrate | OC | EC | Dust

Epidemiological studies

Birth, death, and hospitalization data

SBG-Surface Biology and Geology TIR-Multispectral Mission



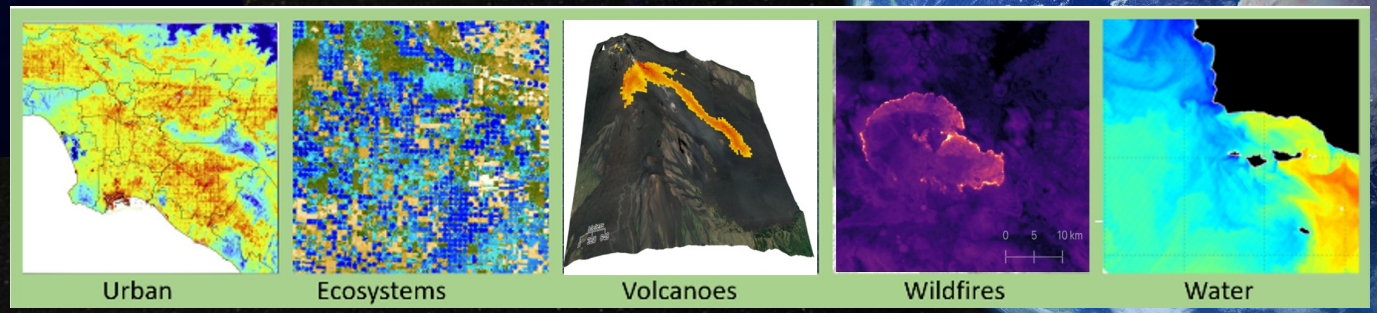
Launch date: end of 2027

TIR instrument

Thermal IR Bands	8.28 µm / 8.63 µm / 9.07 µm / 11.33 µm / 12.05 µm
mid-IR bands	3.98 µm / 4.80 µm
short-wave IR	1.60 µm
NETD	0.2 °K @ 300 °K
GSD	60m
Swath width	935 km
Coverage	Global

VNIR camera

Visible Bands center	655 nm
NIR Bands center	835 nm
SNR	100
GSD	<35 m
Swath width	935 km
Coverage	Global

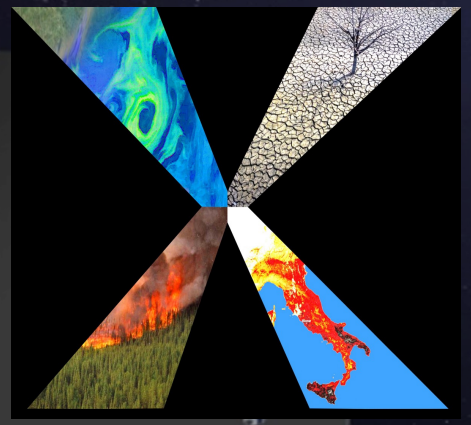


OCO-NEXT Mission

Jet Propulsion Laboratory
California Institute of Technology

Agenzia Spaziale Italiana

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



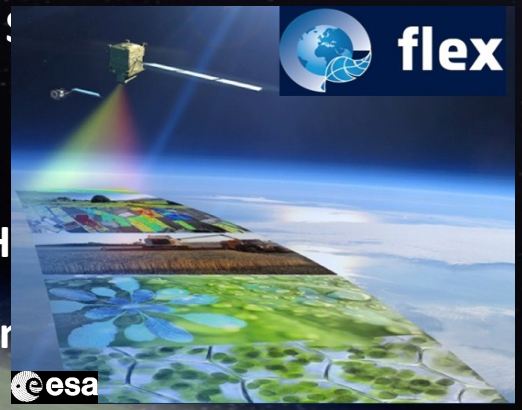
What we expect from OCO-NEXT:

- **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:

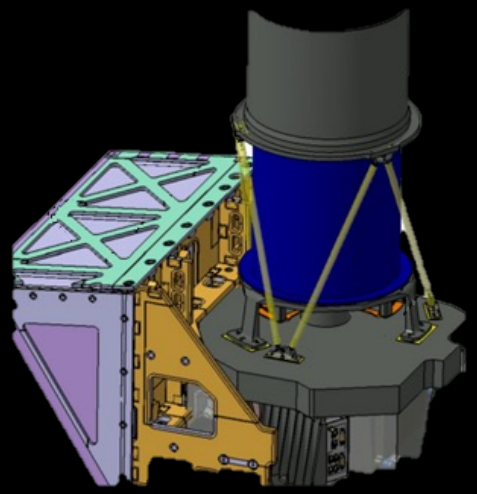
- **SIF instrument (ASI-contributed)**
  - **Band 1 (677-697 nm): O2 B-band/Red S**
  - **Band 2: (740-780 nm): O2 A-band/enhanced SIF**
- **GHG instrument (JPL)**
  - **Band 3 (1591-1660 nm): weak CO2/CH**
  - **Band 4 (2010-2085 nm): strong CO2**
  - **Band 5 (2302-2370 nm): strong CH4 an CO**



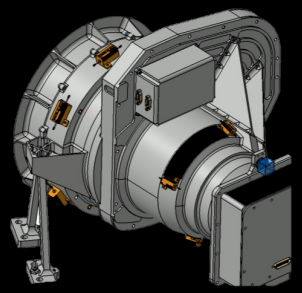
Electro Optical EO Instruments for Small satellites

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

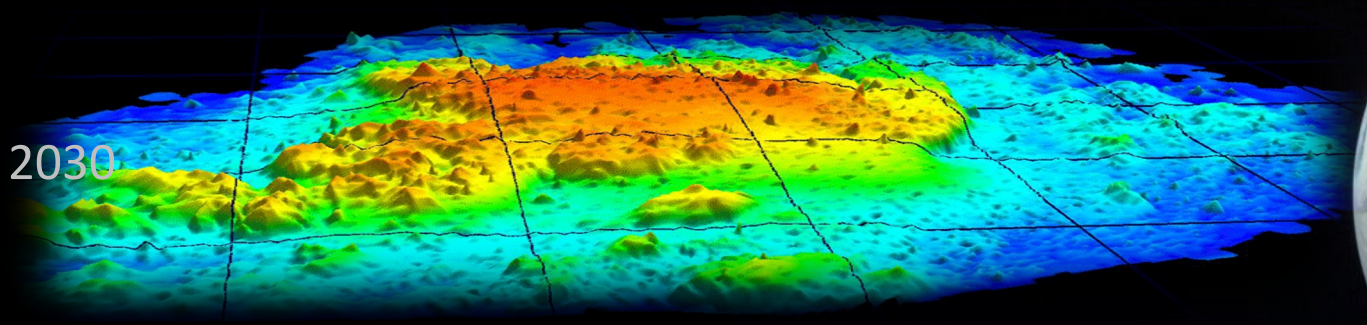
Cloud Aerosol Lidar for Global Scale Observations of the Ocean-Land-Atmosphere System

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