

La missione PRISMA

Patrizia Sacco

Agenzia Spaziale Italiana / Italian Space Agency (ASI)

Workshop "Tecnologie satellitari e analisi multi-rischio"

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THE REFLECTIVE/EMISSIVE BANDS: VIS-NIR-SWIR

Focus on:

 Hyperspectral imagery in the visible and shortwave infrared;



- Pest detection and mapping
- **Biophysical biochemical** parameters estimation
- Top soil properties
- Biodiversity
- Vegetation monitoring

- Alga monitoring
- Identification of bottom type (sea and lake)
- Water quality
- Maritime pollution
- Sand
- Clays (type of clay) Soil moisture content
- Industrial plume Characterization of natural hazards
- Soil pollution

- Decamouflage
- Anomaly and change detection
- Trafficability

- Urban land cover / man-made materials
- Desertification monitoring
- Flood prevention
- Urban mapping

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 s







PRISMA



21st March 2019 02:50 CET

In Mar 2019 – Jan 2020 time frame, the following activities have been completed:

- Satellite & Payload verification
- Sensor calibration with performances demonstrated using in flight data
- Operational qualification of GS

This accomplishments led to opening to users on **21 May 2020**

Mission Overview

PRISMA: PRecursore IperSpettrale della Missione Applicativa

Hyperspectral Area Array



- EO hyperspectral Mission fully funded by ASI as a National project
- Mission conceived as a
 - Pre-operational and technology demonstrator with a focus on
 - Development and in-flight qualification of HYP/PAN payload
 - Development and Validation of a range of products from Level 1 up to Level 2D
- PRISMA P/L operates with a Pushbroom scanning concept.
- 240 total bands in VNIR (#66, 400–1010 nm) & SWIR (#174, 920–2505 nm), partial spectral overlap
- High spectral Resolution (better of 14 nm)
- Medium spatial resolution (30m) and swath (30km)
- PAN camera offers added capability with 5m resolution

Mission Access





□ Primary mode – Maintain the system & Manage user requests (new acquisitions & archived data products)

- CALVAL sites/activities (highest priority)
- Nominal requests from all registered users, subject to quota and a priority level (depends by the user category)
- can promote Nominal Requests already Accepted to Very Urgent (just below CALVAL), for insertion (in day N afternoon) in next plan, covering from Day N+1 @12:00 up to Day N+2 @12:00

□ Foreground mission – Routinely acquire sites defined by the MAG, very relevant to science

• Acquisitions of **#668** sites distributed all over the world, programmed monthly

Background mission – Optimize system resources usage

• Generated to fill-up resources still available after planning of users requests or for systematic acquisitions

Product Level(s)



Product Level(s)

Level-1 and Level-2 products are disseminated as HDF-EOS (Hierarchical Data Format – Earth Observing System).

Level-1: Top-of-Atmosphere spectral radiance

- radiometrically-corrected, calibrated
- Cloud cover, Sun-glint and Land Classification masks

Level-2B: Bottom-of-Atmosphere spectral radiance

- geolocation coefficients appended, not applied
- atmospherically-corrected

Level-2C: Bottom-of-Atmosphere spectral reflectance

- geolocation coefficients appended, not applied
- atmospherically-corrected
- water vapour, aerosols and cloud characterization

Level-2D: Bottom-of-Atmosphere spectral reflectance

- atmospherically-corrected
- geocoding, UTM projection



Nominal Performances

MISSION	
Orbit	LEO SSO, 620km, 10.30 LTDN
Lifetime	5 years
Coverage	Worldwide
Primary Mission mode	User driven (on-demand)
SYSTEM CAPACITY	
Swath	30km, GSD: 30m HYP, 5m PAN
Data volume	daily > 200.000 km2 on all the 430/29 orbits/day
Daily products generation	daily processing of 200 hyperspectral scenes (30 km x 30 km) up to level 2D product.
SYSTEM LATENCIES	Nominal values (MRD requirements)
Revisit time	< 29 days
Re-look time	< 7 days
Response time	< 14 days

PRISM

Data Policy & Exploitation

- A simple policy has been approved by ASI: Free of charge & quasi-Open data to all
- This will allow
 - to lower the PRISMA data access barriers (to new acquisitions and archived data too)
 - to expand the PRISMA user community
 - to simplify the data exploitation
 - to build customer loyalty to PRISMA data
 - to gather a feedback from users, unbiased by external factors like user nationality, data price, etc

- A «quasi-Open» policy
 - Full support to National security needs
 - User Registration and Licence explicit acceptance is required
 - Each User will be allowed to use only a portion of the system resources, through
 Priority and Quota
 - Products use is allowed for scientific research, R&D of new applications, prototype services, commercial

purposes

- Products are costless for the users
- Products cannot be redistributed

- Exploitation with Science and User Community deep involvement
 - PRISMA Advisory Group for data Exploitation supporting the definition/updating of the mission exploitation scenario
 - International Collaborations: CNES, DLR, ESA, NASA-JPL mainly on CALVAL domain
 - Training & Outreach (Workshops, Education events,...)
- System improvement project foreseen in 2024

Mission Statistics – Users Nationality

3185 Licenses to Use activated @ 1 April 2025

- Showing the (statistically) most representative part of the user population:
- 16 nations covers 80% of the users
- the Italian users are only 1/5
- India, USA, Germany and China together account the 1/3 of the users



- 63% of the total users are scientists (52% of the users belongs to non-Italian Science and is the largest category)
- Institutional (7%) and commercial (10%) represents 17% of total users
- Foreign commercial (7.5%) is more than three times the Italian commercial (2.3%)
- 14.5% of user are freelance!



Mission Statistics – Exploitation

The 70% of the thematic exploitation areas which have been declared at registration time, covers in an almost uniform way 30+ domains ranging from Agricolture to Mineral Composition, but with **Agricolture, Geology, Land Cover and Mineral Mapping** among the most selected themes



Archive

PRISMA





Archive quality (cloudiness)









Orders from catalogue

Agenzia Spaziale Italiana







Orders from catalogue

Hydrocarburs exploration (Kuwait)

PRI





Acquisition pre-feasibility tool

PRISMA acquisition feasibility tool is online http://prisma-prefeasibility.asi.it

- is freely accessible even without a PRISMA account
- performs the analysis on a single or multiple Areas of Interest (AoI) described by the lat, lon of their central point
- satellite has in view the AoI plus characteristic parameters of that view (roll angle, solar zenith angle)

PRISMA Pre-Feasibility Tool - Temporary

This Tool provides pre-feasibility service for PRISMA mission

This service is temporary and replaces the PRISMA pre-feasibility service which will be back online shortly.

The pre-feasibility can be requested only through the use of a CSV file which must contain the information on the acquisitions for which the pre-feasibility service is requested.

The CSV file to be uploaded must have a format similar to the following (do NOT insert the heading line and use start/stop dates in the FUTURE):

Start epoch [YYYY-MM-DDThh:mm:ss.sssss]. Stop epoch [YYYY-MM-DDThh:mm:ss.sssss]. Strip lenght [num], Latitude [deg], Longitude [deg], Look Angle Min [deg], Look Angle Max [deg], MinSunZenithAngle [deg], MaxSunZenithAngle [deg], Description[text] 2023-04-10T12:00:00.100000 2023-06-15T12:00:00.300000,1, 45.803146,7.571287,-21,21,10.0,70.0,Torgnon 2023-05.10T0:00:00.01000000 2023-10-15T12:00:00.300000 3. 45.803146,7.571287,-21,21,10.0,70.0 Torgnon

Select file to upload:

Sfoglia... Nessun file selezionato.

Start Pre-feas

ASCII input file 2023-10-06T11:54:38,2023-12-06T12:38:13,1,62.62438742015709,-12.80498245868861,-21,21,10.0,70.0,50 2023-10-06T11:54:38,2023-12-06T12:38:13,1,62.65450461129572,-13.0129605981583,-21,21,10.0,70.0,50 2023-10-06T11:54:38,2023-12-06T12:38:13,1,62.68448120780999,-13.22254553165256,-21,21,10.0,70.0,51 2023-10-06T11:54:38,2023-12-06T12:38:13,1,62.71433334484388,-13.43390159193721,-21,21,10.0,70.0,52 2023-10-06T11:58:13,2023-12-06T12:41:49,1,49.14419559084201,-16.18668641419987,-21,21,10.0,70.0,53 2023-10-06T11:58:13,2023-12-06T12:41:49,1,49.17322450178663,-16.34013900435954,-21,21,10.0,70.0,54 2023-10-06T11:58:13,2023-12-06T12:41:49,1,49.20178151570168,-16.49233834743364,-21,21,10.0,70.0,55

ASCII output file

Start Time,Stop Time,Latitude (deg),Longitude (deg),Roll (deg),SZA (deg),Site,,

2023-10-12 12:19:47.509475296,2023-10-12 12:19:51.619475296,62.62438742015709,-12.80498245868861,-3.1,70.1,49,,Acquisition can be discarded due to SZA uncertainties 2023-10-12 12:19:47.530499117,2023-10-12 12:19:51.640499117,62.65450461129572,-13.0129605981583,-4.1,70.2,50,,Acquisition can be discarded due to SZA uncertainties 2023-10-12 12:19:47.551625817,2023-10-12 12:19:51.661625817,62.68448120780999,-13.22254553165256,-5.1,70.2,51,,Acquisition can be discarded due to SZA uncertainties 2023-10-12 12:19:47.572667934,2023-10-12 12:19:51.661625817,62.68448120780999,-13.22254553165256,-5.1,70.2,52,,Acquisition can be discarded due to SZA uncertainties 2023-10-12 12:19:47.572667934,2023-10-12 12:19:51.682867934,62.7143334484388,-13.43390159193721,-6.1,70.2,52,,Acquisition can be discarded due to SZA uncertainties 2023-10-11 12:06:50.478044778,2023-10-11 12:06:54.588044778,49.14419559084201,-16.18668641419987,-7.0,57.0,53,, 2023-10-17 12:10:10.077412706,2023-10-11 12:06:54.54812078.49.14419559084201,-16.18668641419987,-1.5,59.1,53,, 2023-10-23 12:13:27.722090214,2023-10-23 12:13:31.832090214,49.14419559084201,-16.18668641419987,3.9,61.1,53,, 2023-10-29 12:16:43.139655307,2023-10-29 12:16:47.249655307,49.14419559084201,-16.18668641419987,9.1,63.0,53,,

PRISMA Toolbox

- ✤ In late 2022 the development of a PRISMA toolbox started, reusing a tool developed by Planetek, capable to ingest and visualize PRISMA images ✤ The version 1.0 of the toolbox can fast visualize (RGB combination, selected bands, PAN image etc) the PRISMA products and the metadata; it has been released on 22/09/2023, https://www.asi.it/en/earth-<u>science/prisma/</u>
- A next version (Q3-2025) will also allow to process the ingested products by mean of a Python interface and also will manage EnMAP products



High Geolocation accuracy L2x

PRISM

- On Q1 2022 has been started the development of a system for enabling the higher geolocation accuracy on PRISMA products
- The project is executed by an Italian company (Planetek), with a contract placed after a competitive procedure
- The system will allow to generate L2x products at the full 15m CE90 PRISMA geometric accuracy, by using GCPs automatically extracted by Copernicus Sentinel-2 products



- The GCPs has been validated in Q3-2022 and then gradually generated on worldwide land areas
- Generation has been completed on Q2-2023
- High accuracy products will be available on early 2025 together with new version of L2x processors

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: 2029
 - » SWATH and SNR: on demand techniques of SWATH enlargement and SNR enhancement on a single pass using the platform agility.
 - » Acquisition modes: STRIPMAP and SPOTLIGHT.
 - Spatial resolution of 30m STRIPMAP or 10m SPOTLIGHT
 - Spectral resolution of 10nm over the range 400nm-2500nm
 - Provide PAN images of the targets with GSD of 5m in STRIPMAP and GSD of 2.5m in SPOTLIGHT
 - swath≥30km and indefinite length with a Daily STRIPMAP Imaging Capacity (acquire, downlink and archive) more than 200.000km2.
 - swath≥30km and length up to 210km with a Daily SPOTLIGHT Imaging Capacity (acquire, downlink and archive)more than 200.000km2
 - Low revisit time (72 h with a maximum off-nadir angle of \pm 30 $^\circ\,$)

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PRISMA – Etna Volcano, 24th February 2021





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portal: https://prisma.asi.it

Agenzia Spaziale Italiana

Info, contacts, inquiries: prisma_missionmanagement@asi.it





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THANK YOU FOR YOUR ATTENTION!