Agenzia Spaziale Italiana

Nuove Missioni OT in Cooperazione

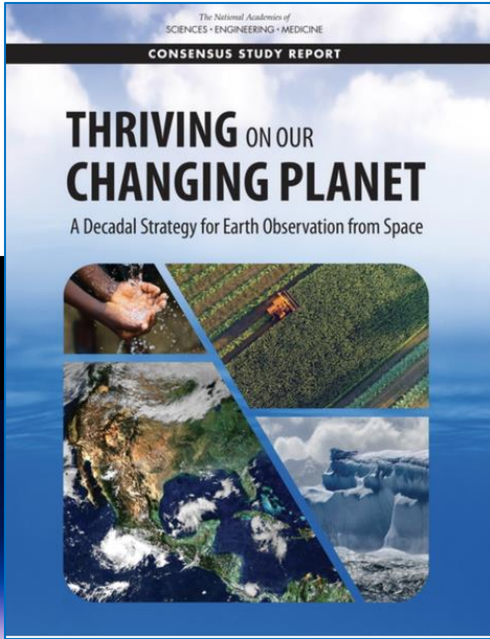
M. Picchiani

Earth Observation Office
Coordination, Data Policy and Downstreaming

Workshop “Tecnologie satellitari e analisi multi-rischio: l’esperienza dei progetti I4DP_SCIENCE e prospettive future”

The SBG-TIR mission

Surface Biology and Geology (SBG) is one of the Designated Observables identified on Earth Science and Applications from Space (ESAS – 2017) decadal survey by US National Academies completed



Key Features

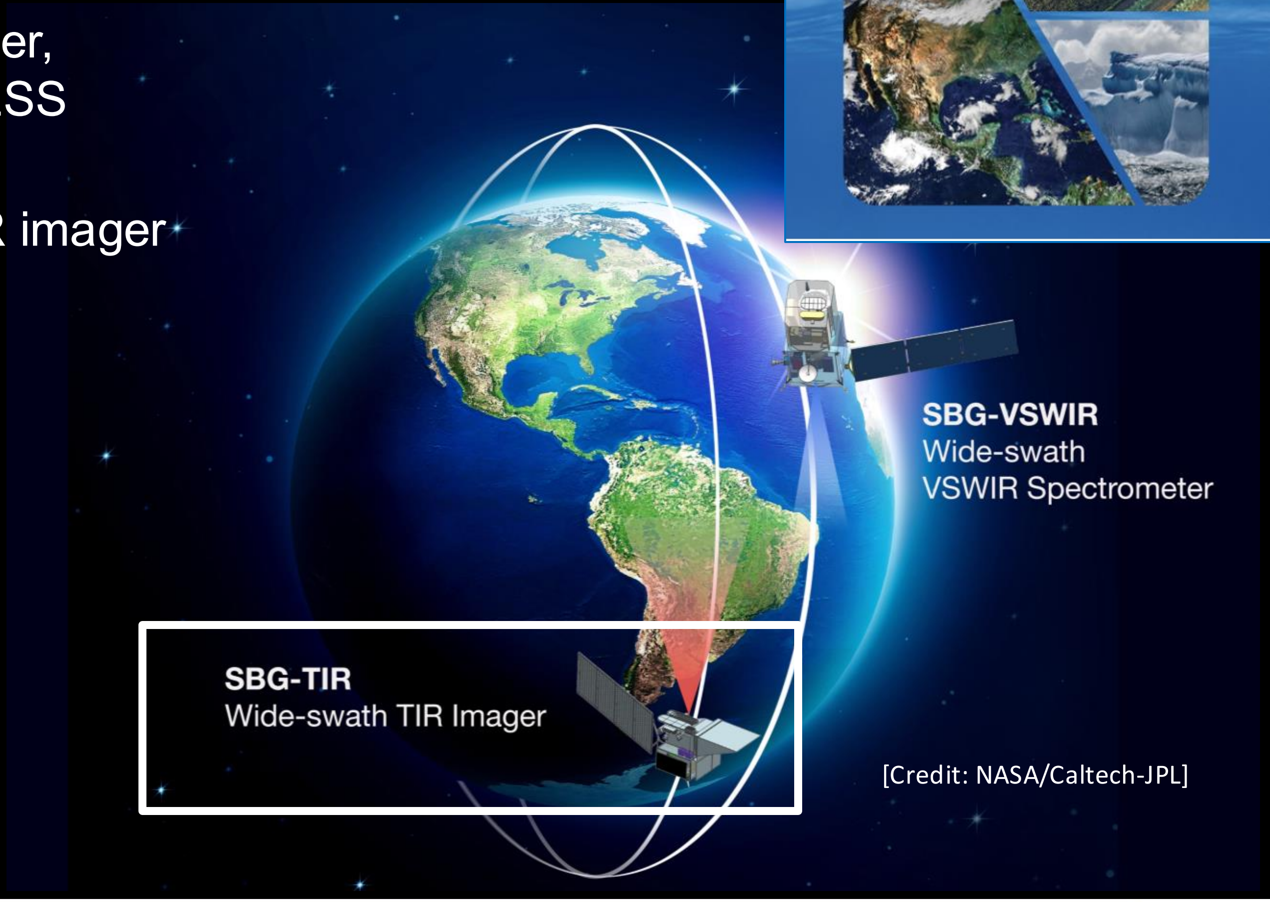
SBG-TIR will address critical questions related to ecosystems, natural resources, hydrology, solid Earth, and weather

- SBG-TIR utilizes a wide-swath Thermal Infrared imager, leveraging technology developed from the ECOSTRESS precursor mission
- VIREO utilizes a wide-swath Visible Near-Infrared HR imager

[illegible]

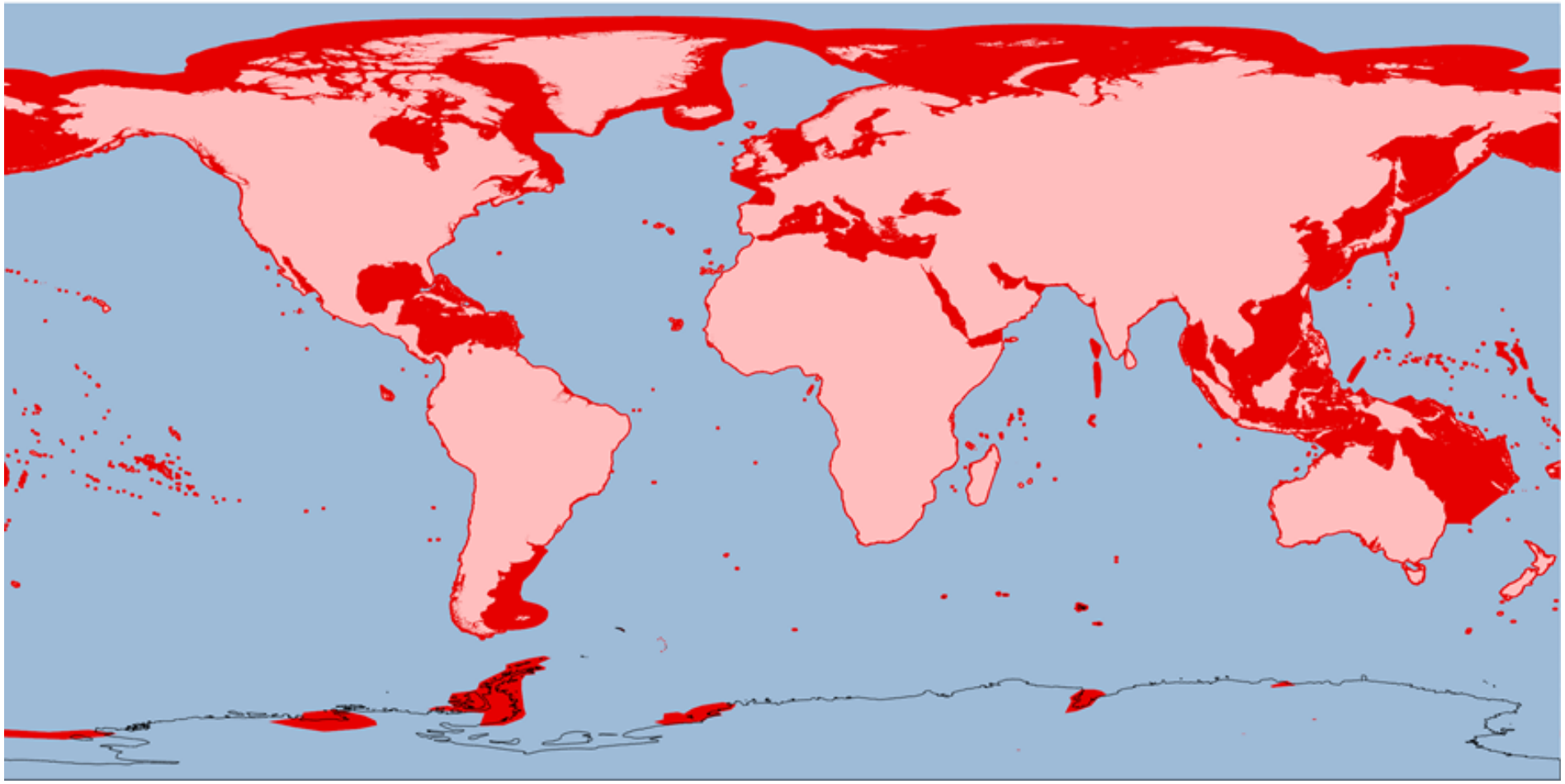
Characteristic	Design Requirement
Spectral Range	VNIR
	0.05 ACT x 0.10 ALT @ (30 m)

Characteristic	Design Requirement
Local Time Descending Node Crossing time	12:30 pm
Revisit at equator	≤3 days
Scan mirror speed	14.9 RPM
Cross-track scan angle	68.8 deg
Swath width	935 km



[Credit: NASA/Caltech-JPL]

Observation Mask OTTER and VIREO



High resolution land (60m) High resolution coastal oceans/ice/islands (60m) Low resolution (1 km)

Flexible design: turn individual channels off/on, change mask if needed

*VIREO off over oceans

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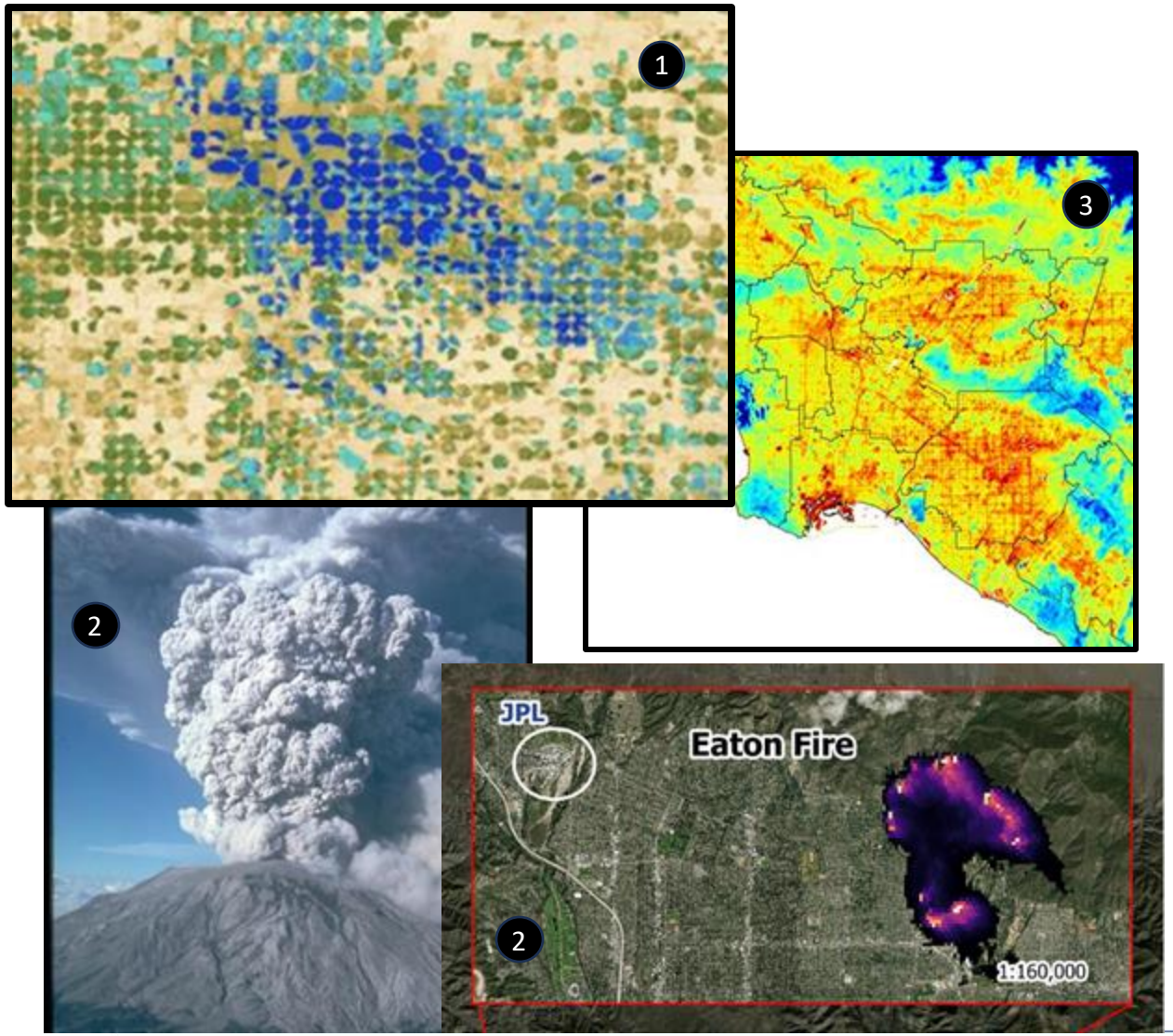
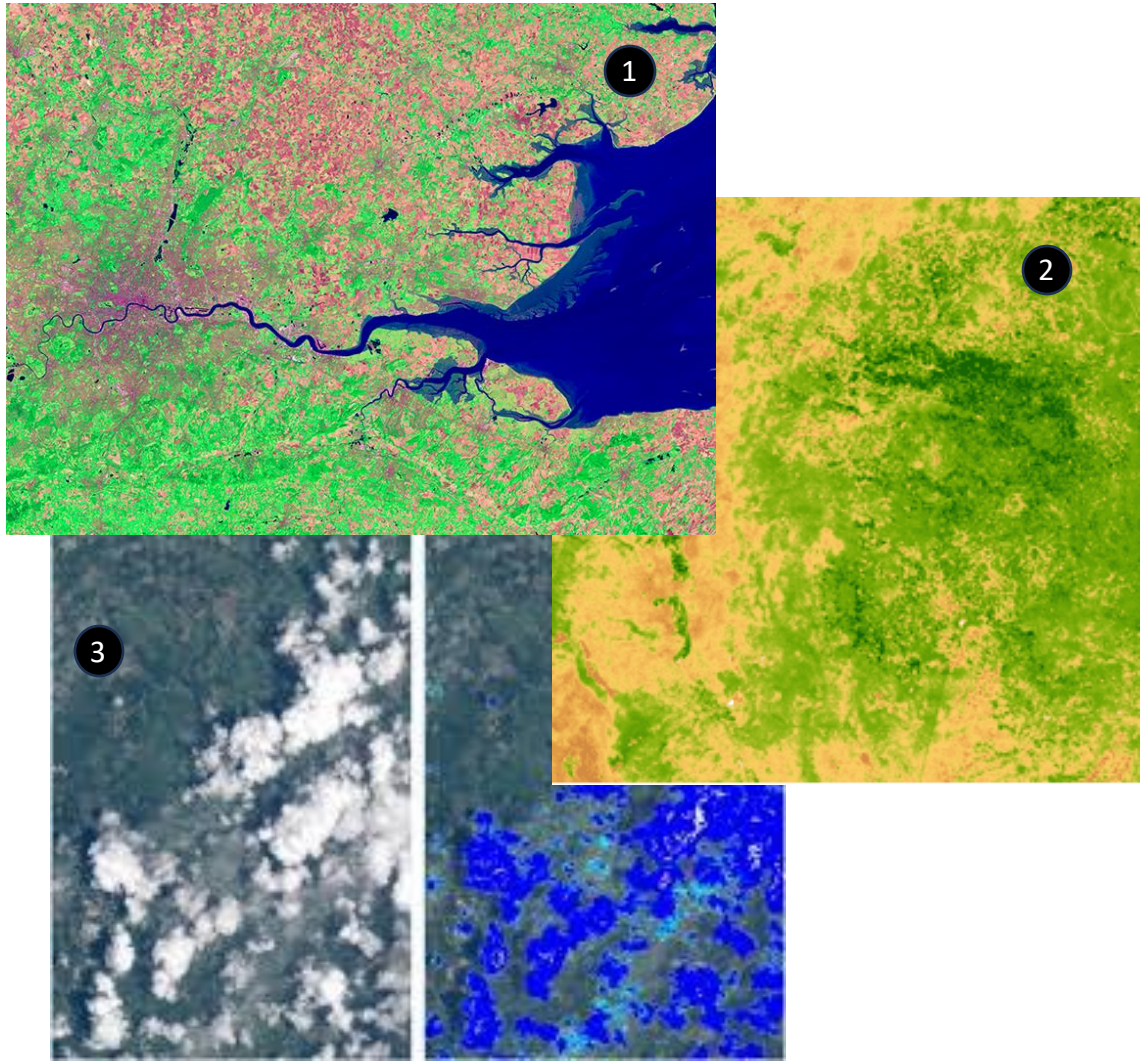
SBG-TIR Backyard BBQ Chart



The SBG-TIR OTTER instrument will provide detailed temperature and emissivity images useful for many studies, especially applications. For example:

1. Food security and agriculture:
   - maximizing food production and more efficient irrigation practices (crop per drop)
2. Mapping wildfires and volcanic hazards
3. Urban resilience: Keeping cities cool
4. Discovering critical mineral and energy resources

SBG-TIR Backyard BBQ Chart



The SBG-TIR VIREO instrument will provide complementary information in VNIR spectral range, also providing specific products like:

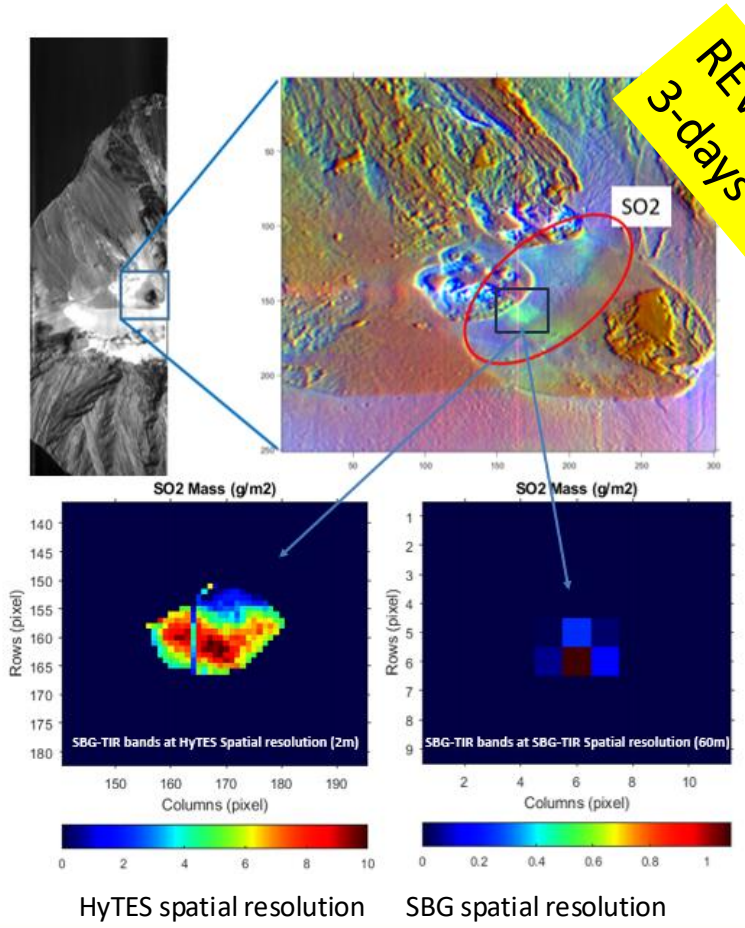
1. Surface reflectance
2. NDVI
3. Cloud Mask information

SULFUR DIOXIDE AND TEMPERATURE ANOMALIES FOR VOLCANO UNREST MONITORING

SO_2 Retrieval obtained with LUTp procedure (Corradini et al., 2008, 2008, 2010) applied to simulated SBG-TIR bands (8.7, 10.3, 11.3 mm) using HyTES data over Stromboli Volcano (Italy)

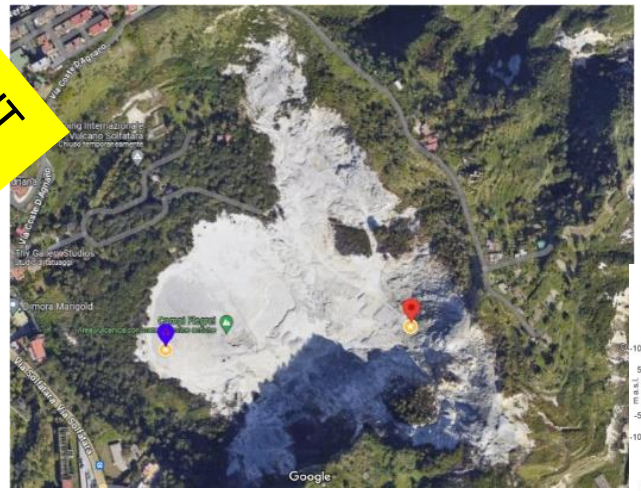
HyTES airborne campaign 2023

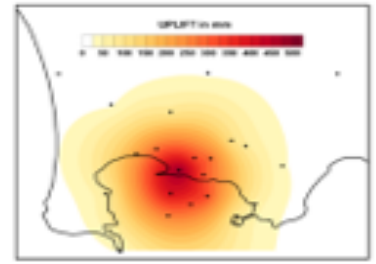
SBG data is able to detect small degassing plumes during non eruptive periods

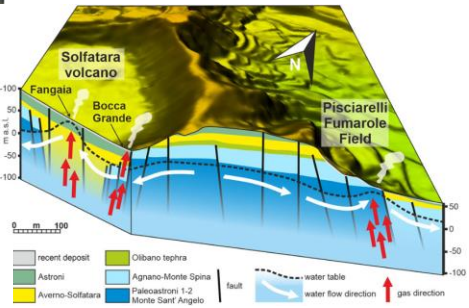


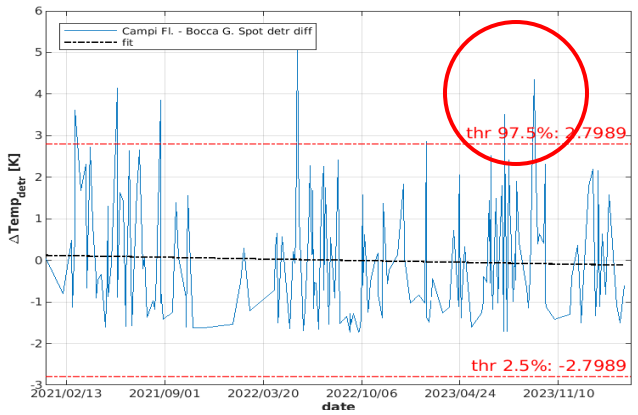
HyTES spatial resolution SBG spatial resolution

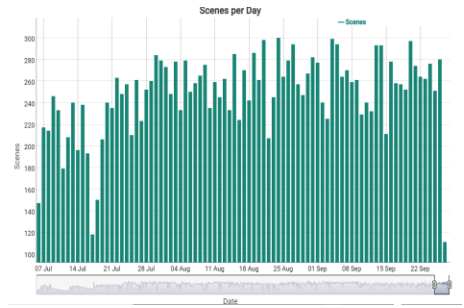
ECOSTRESS demonstrate the importance of high revisit time for volcano unrest monitoring Time Series analysis for Campi Flegrei Volcano











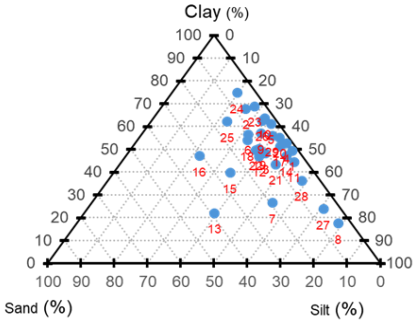
July 22/2023 and September 21/2023 thermal anomalies observed before the seismic swarm (September 23)

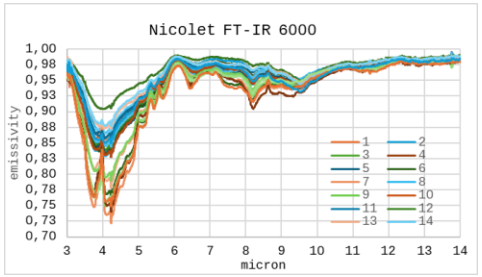
ECOSTRESS > 500 IMAGES SINCE 2018

ASI-THERESA PROJECT

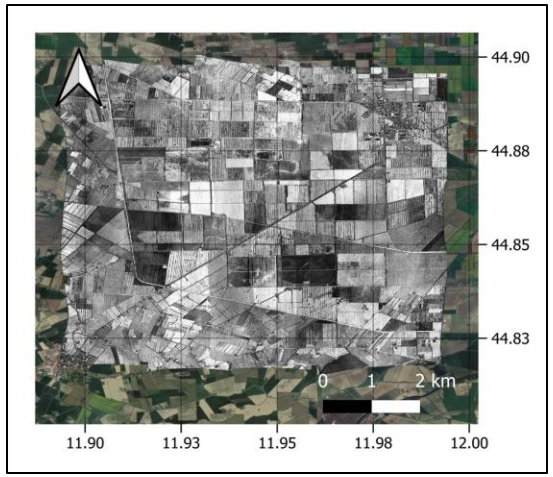
SBG TOPSOIL PROPERTIES RETRIEVAL: THE JOLANDA DI SAVOIA FARMLAND (ITALY) TEST CASE

The farm site is located in the Jolanda di Savoia in North-East Italy (Lat. 44.87°N, Lon. 11.97°E). Topsoils are characterised by a significant variability related to the presence of buried paleo-channels. A HyTES airborne survey, within the ESA-ASI-NASA 2023 European Airborne Campaign, was acquired on the Jolanda site on June 22, 2023. A contemporary S2 image was available.

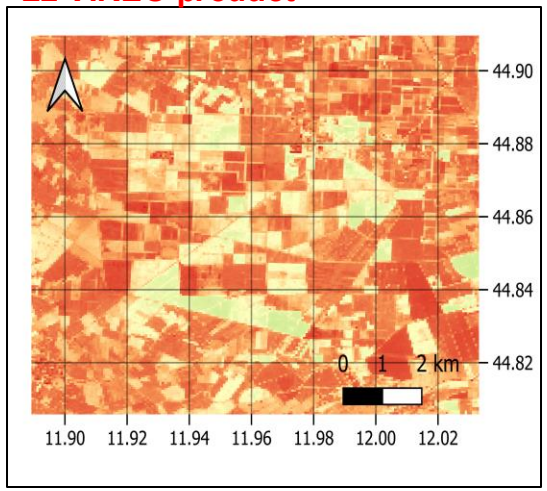




HyTES data Spatially corrected L1 (9.8 micron) to simulate SBG

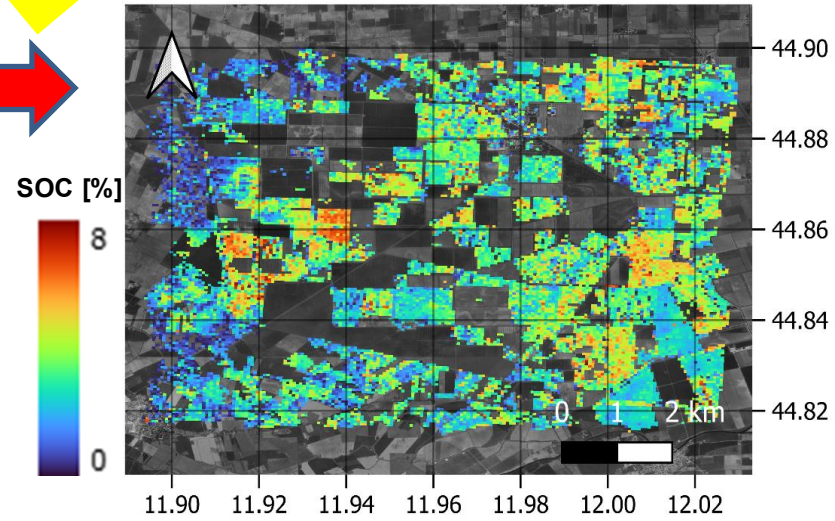


NDVI from S2 data to simulate L2 VIREO product

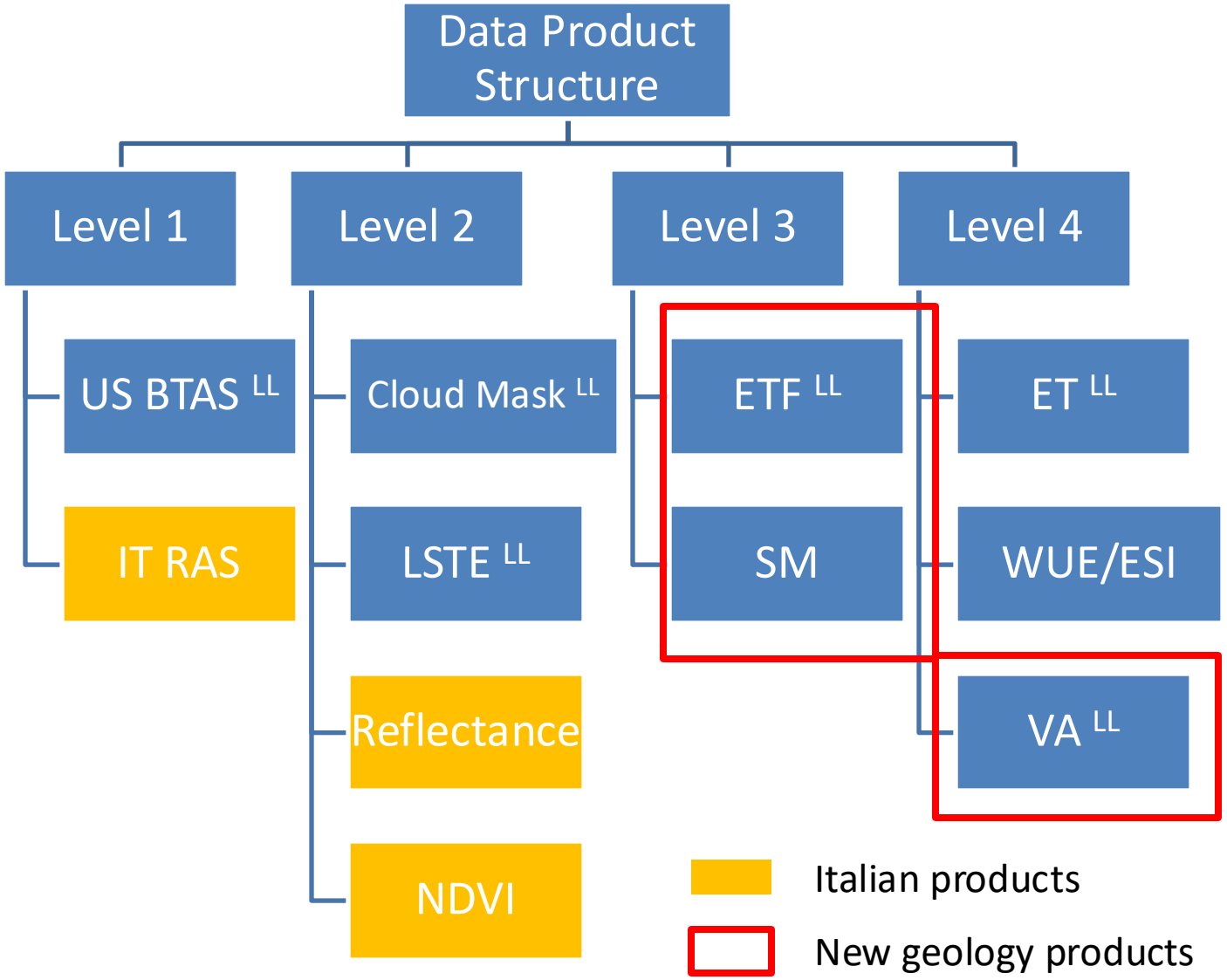


OTTER-VIREO INTEGRATION

SOC retrieval on SBG-TIR (VNIR-LWIR) – GPR algorithm



TIR - VNIR Science Data Product Organization



ACRONYMS

BTAS – Brightness Temperature at Sensor
LSTE – Land Surface Temperature and Emissivity
NDVI – Normalized Difference Vegetation Index
ETF – Elevated Temperature Features
WUE – Water Use Efficiency
ESI – Evaporative Stress Index
VA – Volcanic Activity
SM – Surface Mineralogy

LL – Low Latency

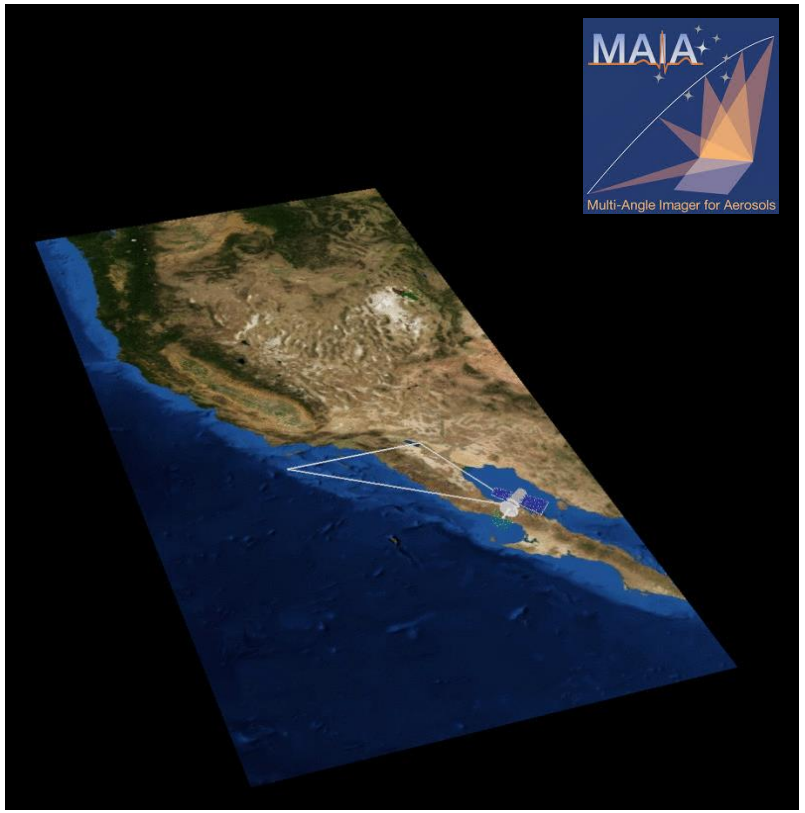
Many of the Products have already been developed with ECOSTRESS

The MAIA mission

Jet Propulsion Laboratory
California Institute of Technology

ASI and NASA join forces on air pollution innovative mission

The two space agencies are partnering to build and launch the Multi-Angle Imager for Aerosols (MAIA) mission, which is based on pointable spectropolarimetric camera (with 14 bands in UV to SWIR spectral range) aimed at investigating the health impacts of tiny airborne particles (PM) polluting some of the world's most populous cities.



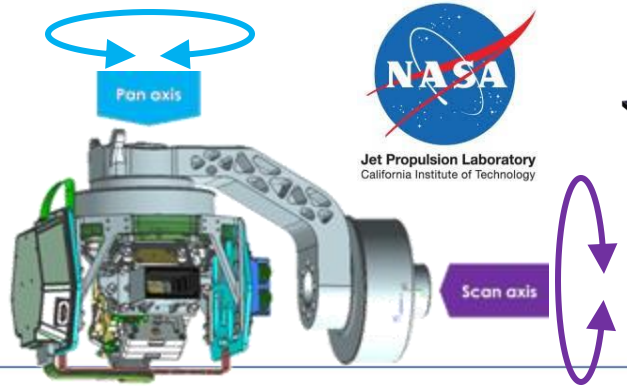
MAIA will explore linkages between exposure to different types of PM and human health

Daily-averaged total PM_{10}, total $PM_{2.5}$, and speciated $PM_{2.5}$ will be mapped in selected areas on a 1-km grid

Sulfate | Nitrate | OC | EC | Dust

Birth, death, and hospitalization records (privacy protected)
Association of PM exposure with health effects

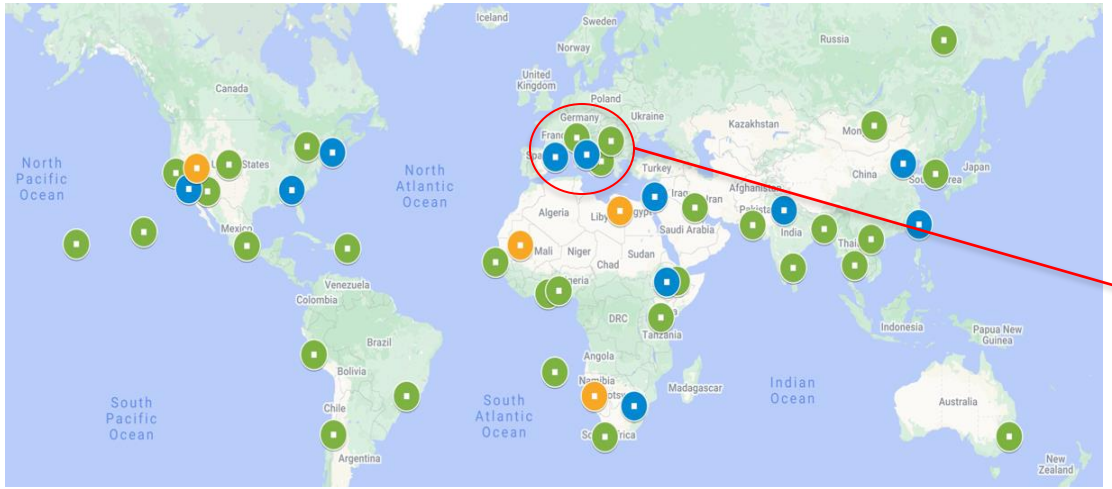
MAIA satellite instrument



PLATiNO-2 spacecraft

Surface measurements

MAIA observation sites worldwide



- Primary Target Areas (PTAs): Surface monitor deployments, epidemiological studies
  - 3 - 4 satellite observations/week
- Secondary Target Areas (STAs): Air quality and climate studies
  - Typically 1 - 3 satellite observations/week
- Calibration/Validation Target Areas (CVTAs)
  - Instrument and algorithm performance maintenance

- Barcelona: 41.0N, 1.4E PTA
- Milan (included Turin and parts of Switzerland): 45.80N, 8.80E **STA**
- Rome-Bologna: 43.1N, 11.6E **PTA**
- Taranto: 39.7N, 16.8E **STA**
- Belgrade: 43.6N, 21.6E **STA**

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INSIEME PER UN FUTURO SOSTENIBILE

Planned MAIA EVI standard data products (NetCDF format)

Data Product	Contents	Spatial Grid	Temporal Info
L1 Georectified Imagery	Map-projected radiance and polarization data	250 m	Time/days of target overpass
L2 Cloud Mask	Cloud confidence and quality indicators	1 km	Time/days of target overpass
L2 Aerosol Product	AOD, fractional AOD by size/shape/absorption, size distribution, refractive index	1 km	Time/days of target overpass
L2 PM Product	PM_{10}, $PM_{2.5}$, sulfate, nitrate, OC, EC, dust $PM_{2.5}$	1 km	24-hr averaged/ days of target overpass
L4 PM Product	Gap-filled PM_{10}, $PM_{2.5}$, sulfate, nitrate, OC, EC, dust $PM_{2.5}$	1 km	24-hr averaged/ daily
Ancillary Geographic Product	Land use information	125 m - 1 km	Static
Surface Monitor/Geostatistical Information Product	Surface monitor PM data and meteorological data at monitor sites	Point data	Days when surface monitor data are collected

The LUCE mission

Università degli Studi
della Basilicata

LUCE: A multi-purpose space LIDAR mission for observation of Earth's atmosphere, surface and oceans and their interactions

State-of-the-art three-wavelength Raman-Elastic-Fluorescence LIDAR, benefitting from the UV, visible and infrared pulses emitted by a powerful Nd:YAG laser source and from the exploitation of all possible atmospheric/surface/oceanic elastic and anelastic echoes stimulated with these three wavelengths.

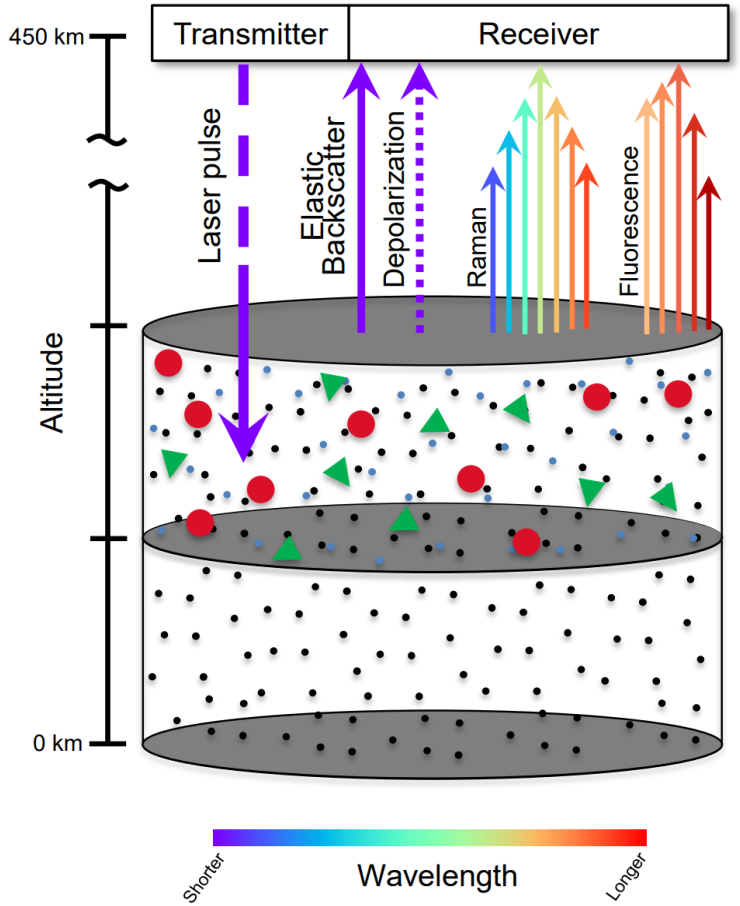
Explore full lidar capabilities

Elastic scattering: change in light's direction

Depolarization: change in light's polarization state

Raman scattering: change in light's direction *and* an exchange of energy

Fluorescence: emission of light that has been absorbed



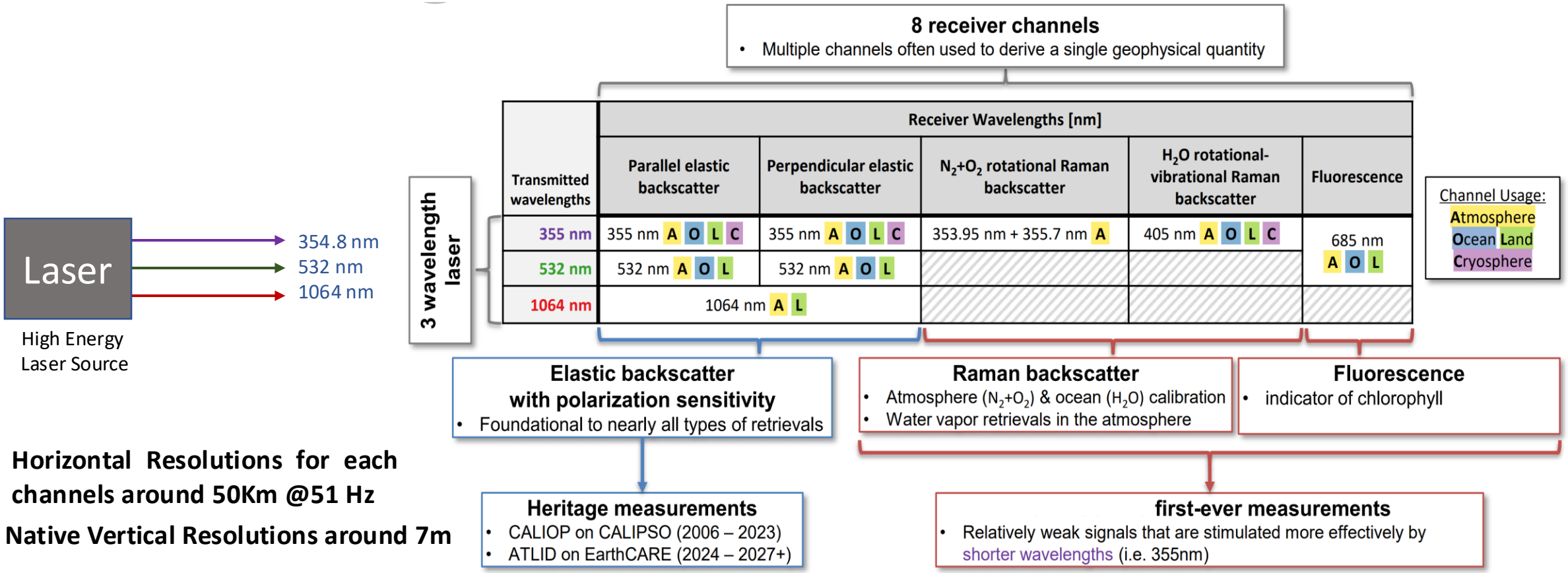
Raman spectrum: wavelength shifts correspond to the vibrational-rotational energy level structure of the scatterer
→ **unique fingerprint**
- Allows one to collect backscatter from a specific species of interest

Fluorescence spectrum: specific to a species, only some species fluoresce
→ **unique fingerprint**
- Identifier of the type particle in the volume

Courtesy of NASA

A unique multi-wavelength elastic-Raman-fluorescence backscatter lidar

Laser pulses at **three wavelengths, UV, visible and near infrared**, and the **reception of echoes on 8 different channels** to measure elastic scattering, depolarization factor, Raman scattering and fluorescence.
This asset represents an **unprecedented configuration among space lidar missions**.
This **unique configuration in the world** candidate the mission to become a **reference in the field space lidar technique** and enables a huge number of scientific applications.



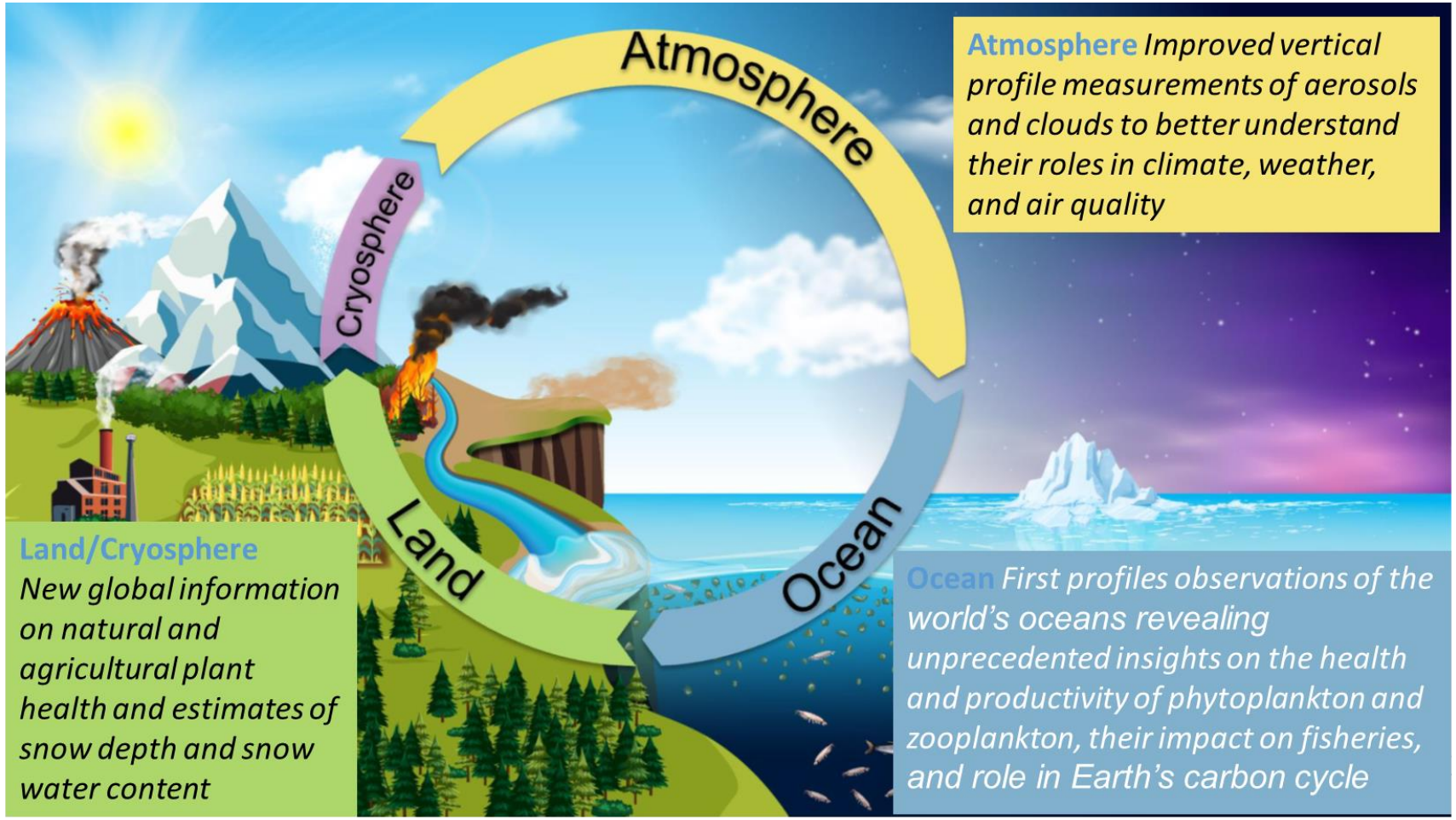
Horizontal Resolutions for each channels around 50Km @51 Hz

Native Vertical Resolutions around 7m

Scientific Goals

The **mission requirements include several primary and secondary scientific objectives**. The mission's **opens the way to further applications and new scientific activities.**

The possibility of **combining Luce data with data from other Earth, Ocean and Atmospheric observation missions** further amplifies the number of possible scientific returns that will be generated by this innovative mission.



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Thank you for your attention

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