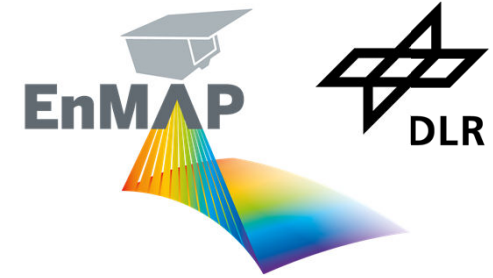


ENMAP: THE GERMAN HYPER SPECTRAL MISSION

EnMAP - Environmental Mapping and Analysis Program



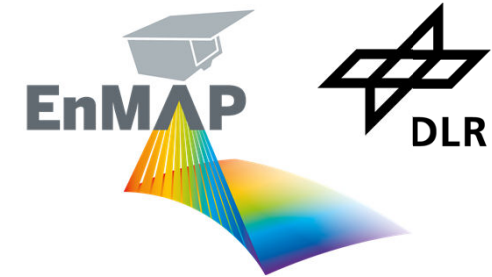
EnMAP – Mission Objectives



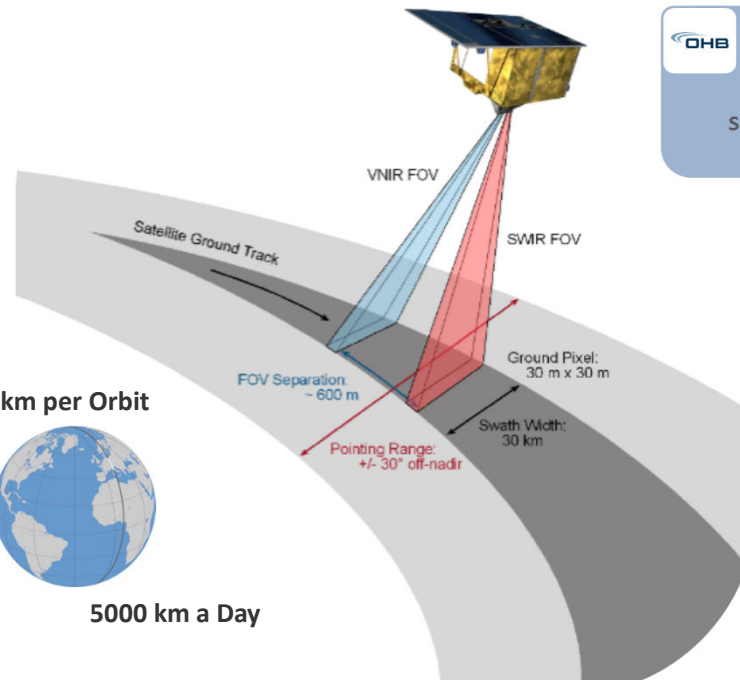
- Environmental Mapping and Analysis Program (EnMAP) is a German hyperspectral satellite mission for **characterization and monitoring** of the Earth's surface on a global scale
- EnMAP provides **quantitative surface parameters** about the state and changes of terrestrial and aquatic ecosystems.
- **Main objectives of the mission:**
 - 1) the study of globally interconnected environmental processes.
 - 2) the study of the multiple impacts of human interventions on ecosystems.
 - 3) supporting natural resource management. By quantifying and modeling important ecosystem processes, EnMAP contributes significantly to our understanding of the Earth system.



EnMAP – Mission and Sensor Characteristic



Orbit characteristics		
Orbit / Inclination	sun-synchronous / 97.96°	
Target revisit time	27 days (VZA ≤ 5°) / 4 days (VZA ≤ 30°)	
Equator crossing time	11:00 h ± 18 min (local time)	
Instrument characteristics		
	VNIR	SWIR
Spectral range	420 - 1000 nm	900 - 2450 nm
Number of bands	91	134
Spectral sampling interval	6.5 nm	10 nm
Spectral bandwidth (FWHM)	8.1 ± 1.0 nm	12.5 ± 1.5 nm
Signal-to-noise ratio (SNR)	> 400:1 @495 nm	> 170:1 @2200 nm
Spectral calibration accuracy	0.5 nm	1 nm
Ground sampling distance	30 m (at nadir; sea level)	
Swath width	30 km (field-of-view = 2.63° across track)	
Acquisition length	1000 km/orbit - 5000 km/day	



1000 km per Orbit



5000 km a Day

DLR
Project Management
 DLR Space Administration

GFZ
Scientific Principal Investigator
 GFZ Potsdam
EnMAP Science Team

OHB
Space Segment
 Sensor | Platform

DLR
Ground Segment
 Operations | Payload | Processing
 DLR-GSOC | DLR-DFD | DLR-IMF

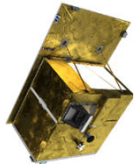
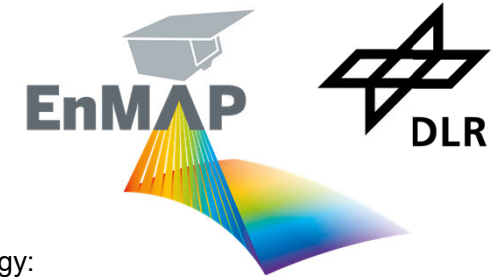
Supported by:



on the basis of a decision by the German Bundestag

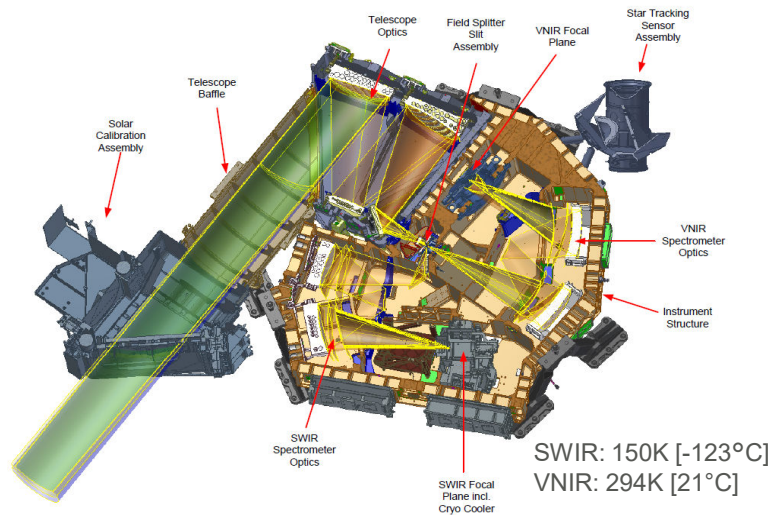
www.enmap.org

EnMAP – Sensor Characteristics



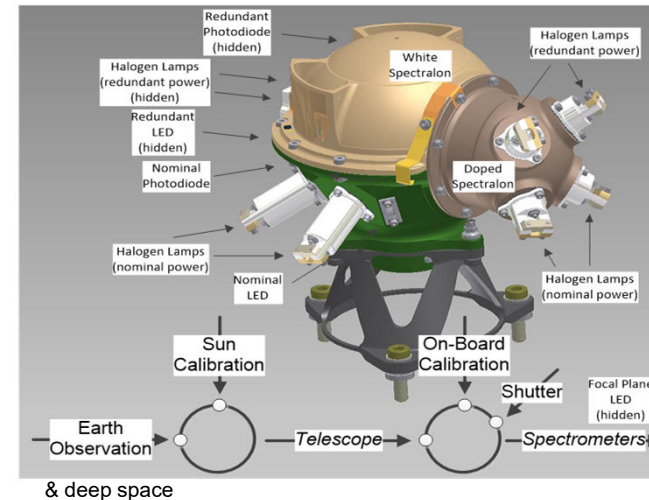
Size of satellite: 3.1 m × 2.0 m × 1.7 m
 Launch mass of satellite: 980 kg (including 55 kg hydrazine)

HSI Instrument: Independent VNIR & SWIR spectrometers
 Curved prism design to maximize spectral and spatial uniformity



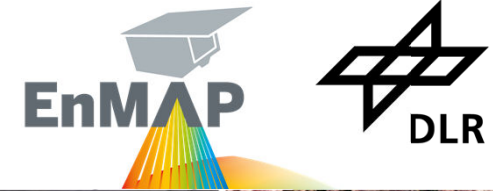
EnMAP Calibration/Validation strategy:

- On-board calibration (OBCA)
- Cal/ val activities (ground segment)
- External validation (science segment)



EnMAP	VNIR	SWIR
Spectral range	420 nm to 1000 nm	900 nm to 2450 nm
Spectral (res.)	4.8 nm to 8.2 nm (1000 px, 91 ch)	7.4 nm to 12.0 nm (1000 px, 134 ch)
Spatial (res., swath)	30 m, 30 km	30 m, 30 km

EnMAP – What a Year!

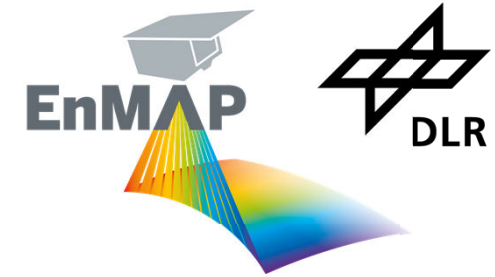


EnMAP data @DLR [2022/2023]

EnMAP – Data Access

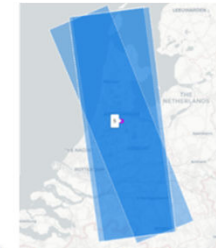
EnMAP proposal and data portal -> **Registration**

<https://planning.enmap.org/>



Submit proposal

- Category I
- Based on science AO
 - With proposal



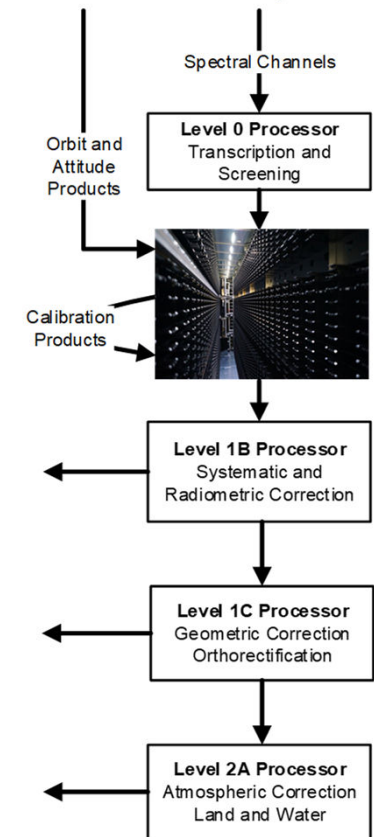
Plan and submit future observation requests

Register

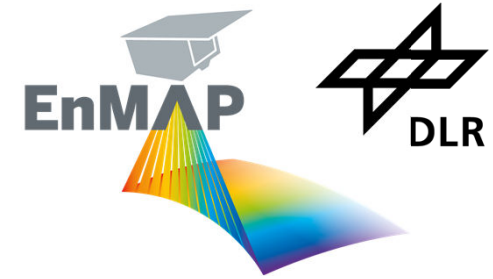
- Catalogue
- No proposal

Search and order from archive (EO-Web)

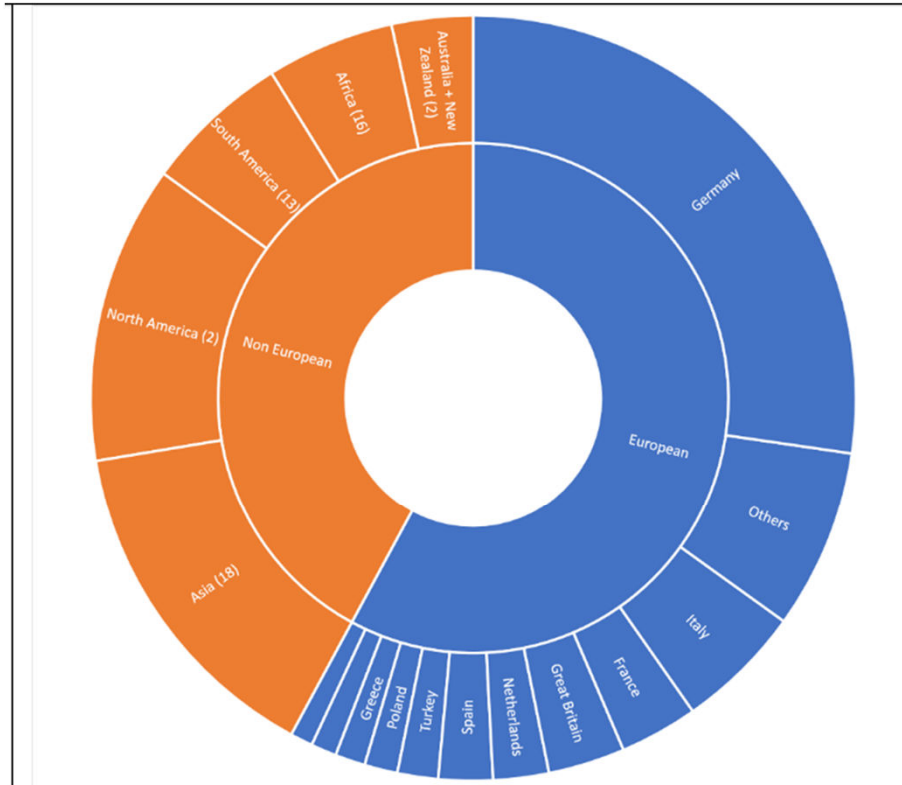
Session I „EnMAP Mission Status“
The EnMAP User Inquiries
Nicole Pinnel



EnMAP – User Statistics



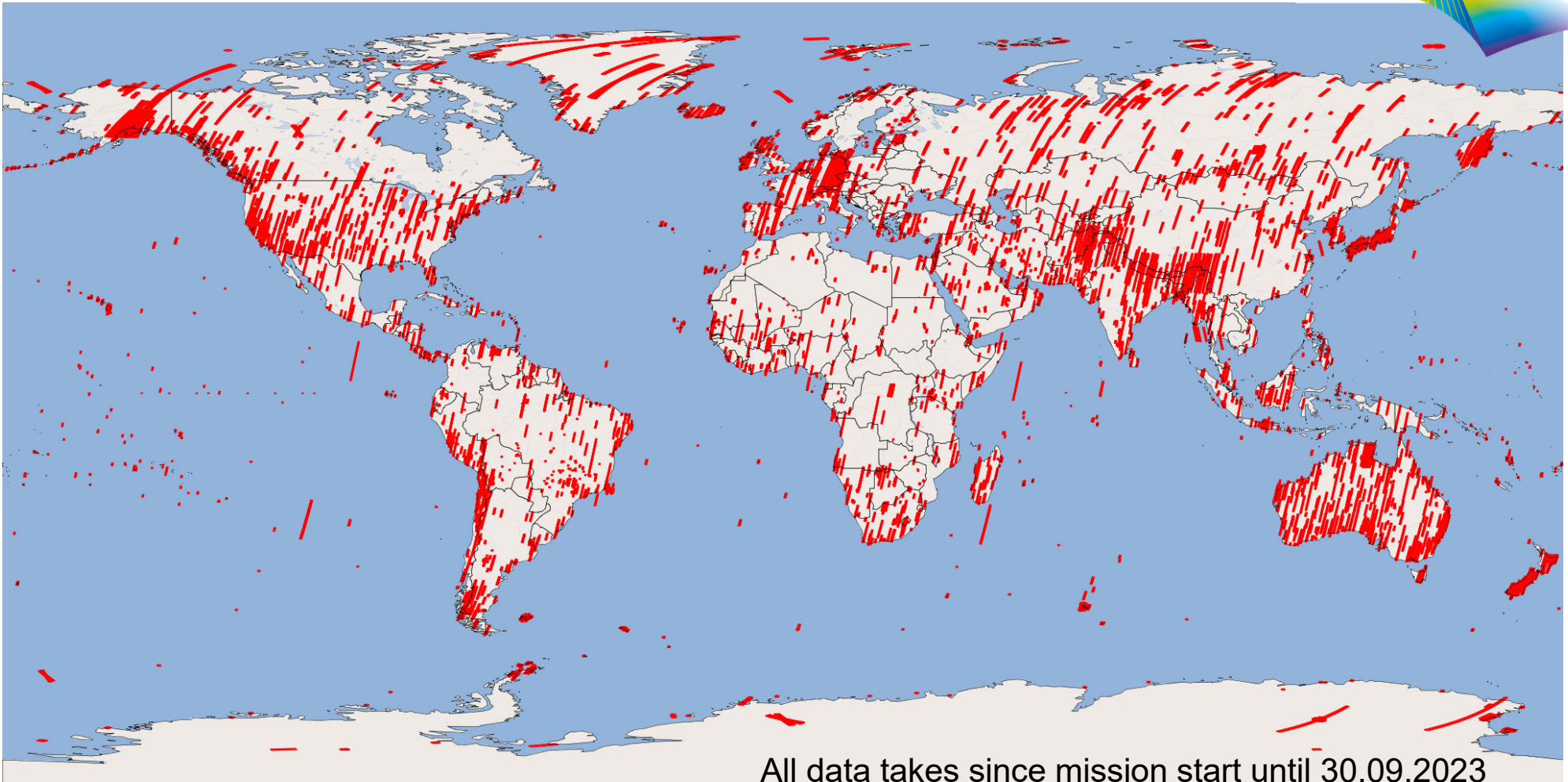
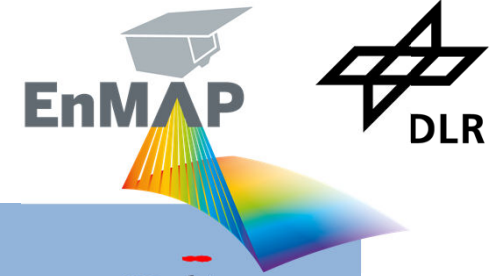
Icon	Topic	02.11.22-30.09.23	
		Proposal	Total Tiles
	VEGETATION	148	9477
	GEO/SOIL	100	2856
	WATER	41	2275
	SNOW/ICE	7	698
	URBAN	8	307
	ATMOSPHERE	10	1047
	HAZARD/RISK	6	205
	METHODS	11	531
	CAL/VAL	19	2261



Since beginning of Commissioning Phase until 30.06.2023 (end of reporting period) with total of 1584 Users of 83 different countries.

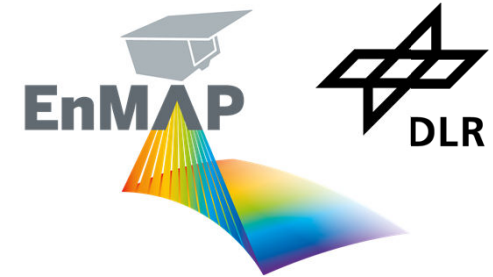
Category	Number
User registered	1.424
Cat-1 User	1.815
Proposals	350
Catalogue User	1.012

EnMAP – Acquisition

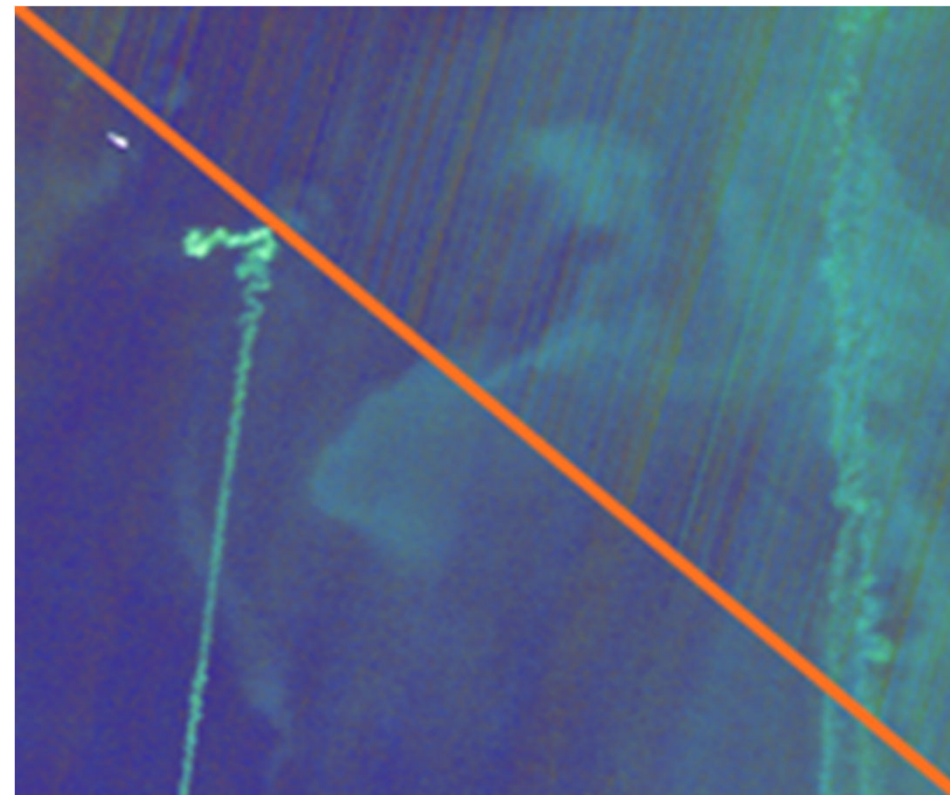


All data takes since mission start until 30.09.2023

EnMAP – Data Quality

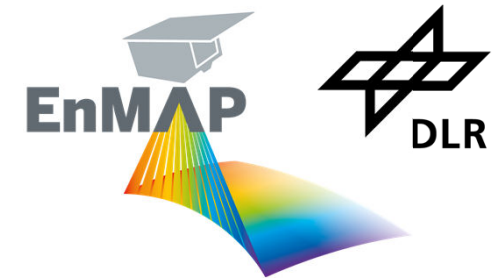


- Large cal/val activities and external validation
 - Data quality exceeding all requirements!
 - TOA radiance
 - Geometric accuracy. Co-registration
 - BOA reflectance
 - Smile and keystone <2%
 - And more..
- Regular Processor update for improvement of data quality
 - Several progress
 - Across-track striping
 - Water-leaving reflectance
 - VNIR-SWIR co-alignment
 - Absolute geometric accuracy
 - Cirrus-correction over snow
 - Acquisition pointing issue
 - Extension of wavelength
 - Several minor issues

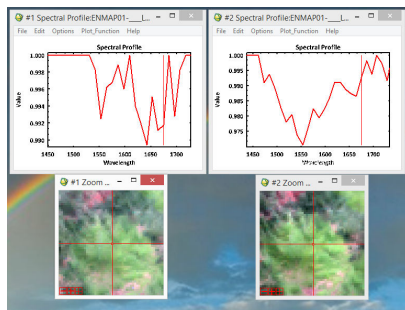


Session II „EnMAP data processing and quality “

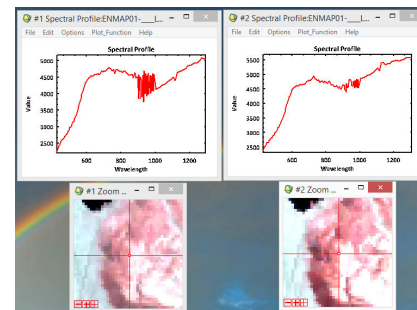
EnMAP – EnMAP processor update



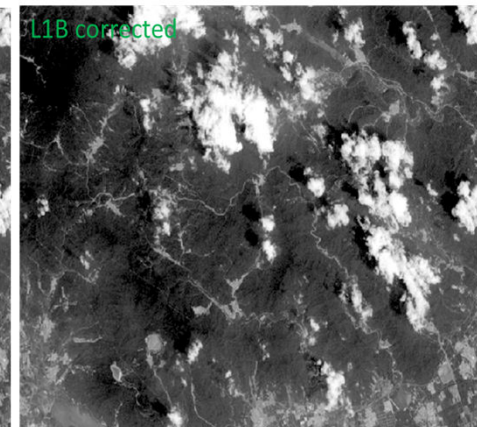
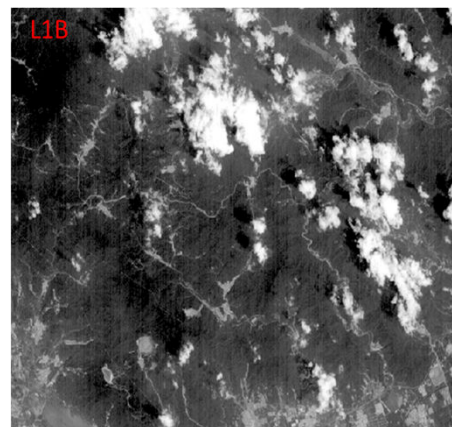
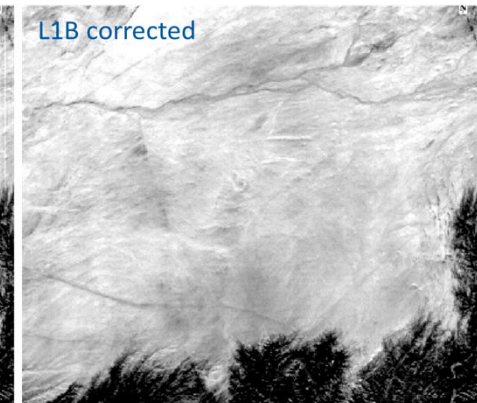
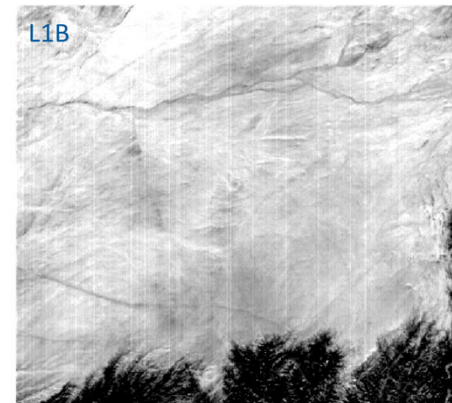
- EnMAP processor updated on 29. March 2023 (v01.02)
- Changes include:
 - Across-track de-striping algorithm implemented
 - Improved VNIR-SWIR co-registration
 - **Unmasking of several spectral bands in the SWIR regions at the edges of the water bands: between 1450-1500 & 1730-1760 nm, important for mineral mapping (e.g epidote, gypsum)**
 - **Reprocessing of archived EnMAP data**
 - **use the latest version when more than one version of the product exists.**



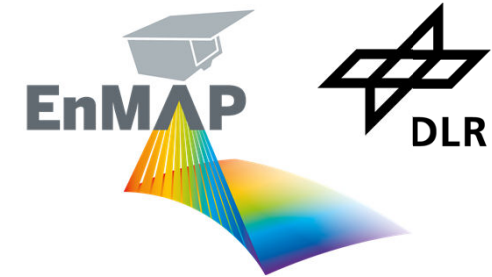
Epidote feature at 1550 fully resolved



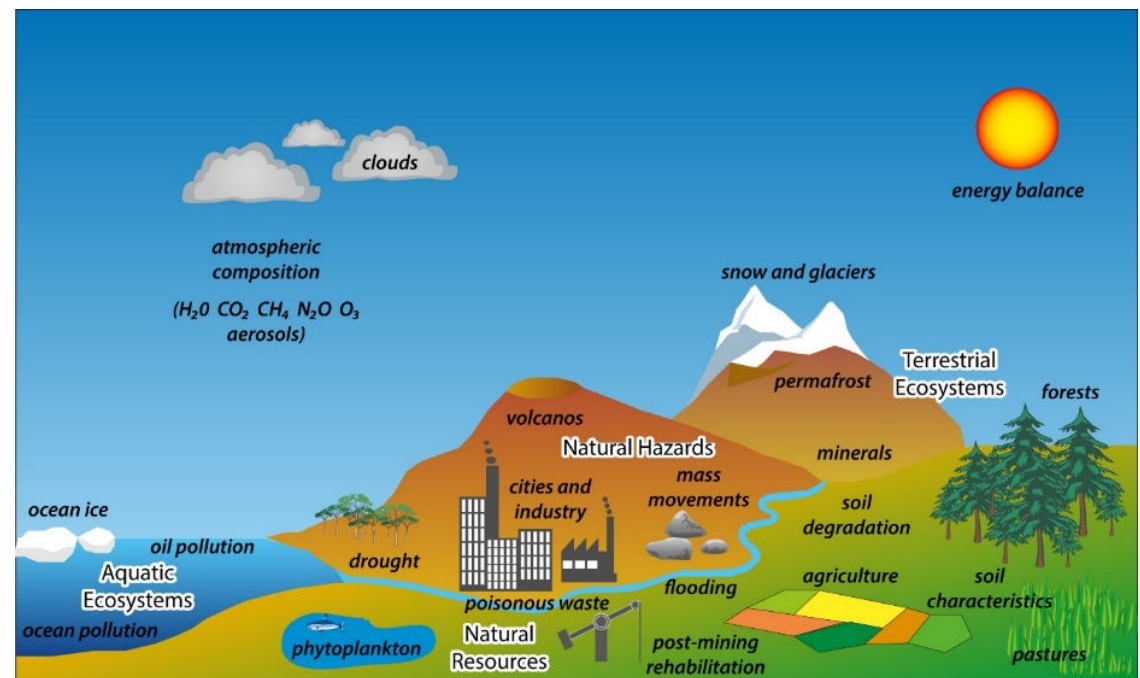
Reduction of noise in the sensor overlap region (ferric iron feature)



EnMAP – Science and Applications



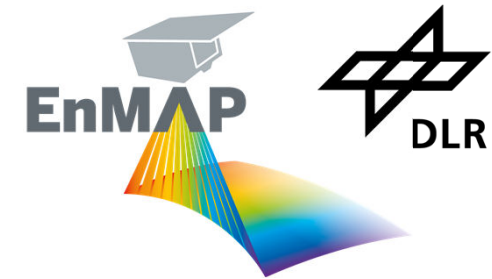
- **Core themes:** Study environmental changes, investigate ecosystem responses to human activities, and monitor the management of natural resources
- Key applications areas
 - **Vegetation and terrestrial ecosystems** (canopy biochemistry, plant stress, plant composition)
 - **Geology and soils** (mineral resource exploration, soil properties and soil health, soil degradation)
 - **Aquatic ecosystems** (algae composition, water quality)
 - **Snow and ice** (properties, dust)
 - **Urban areas** (surface materials)
 - **Environmental pollution** (plastics, heavy metals, acid mine drainage, hydrocarbon leakages, greenhouse gases)
 - **Hazard and risks** (landslides, swelling soils, floods, droughts, volcanoes)



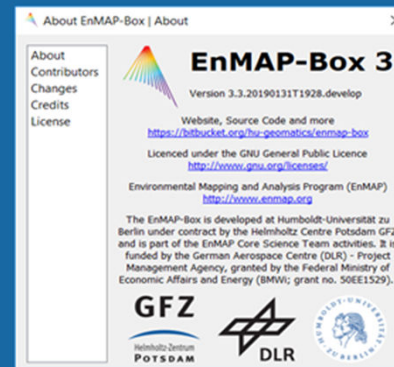
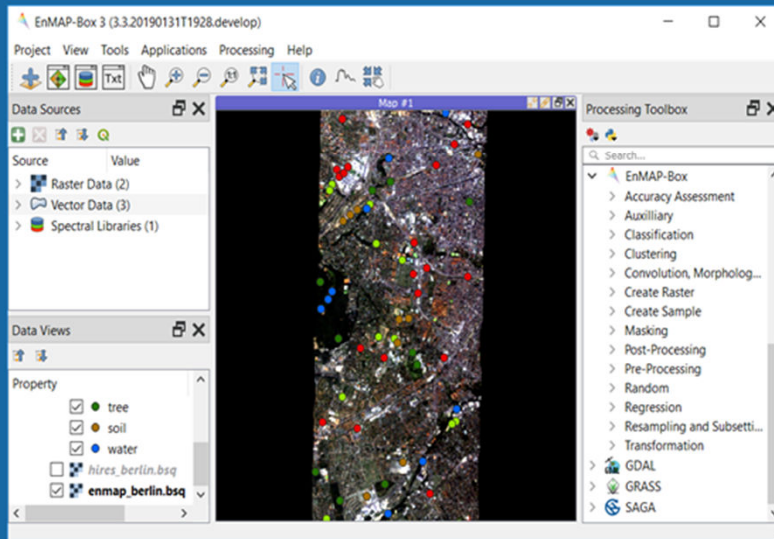
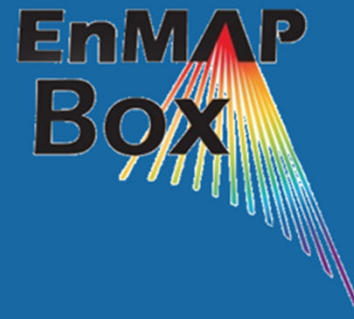
Session IV-VI -> 11.October 2023

EnMAP science plan, www.enmap.org, 2022

EnMAP – Toolbox

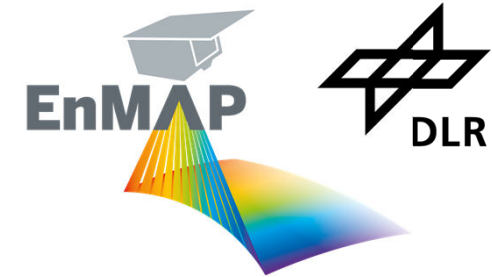


Free and open-source toolbox
for visualization, processing &
analysis of hyperspectral data



Session I „EnMAP Mission Status“
What's new in the EnMAP-Box 3.13?
Andreas Janz

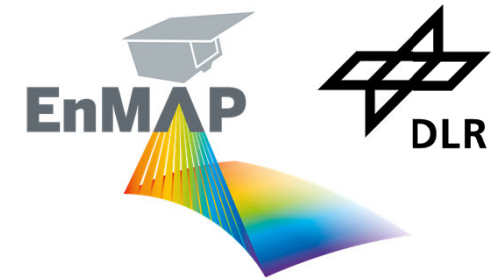
EnMAP – HYPERedu



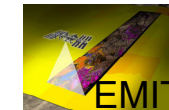
Online learning initiative on principles, methods and applications of hyperspectral remote sensing

Session I „EnMAP Mission Status“
HYPERedu online learning program
Saskia Förster/Arlena Brosinsky

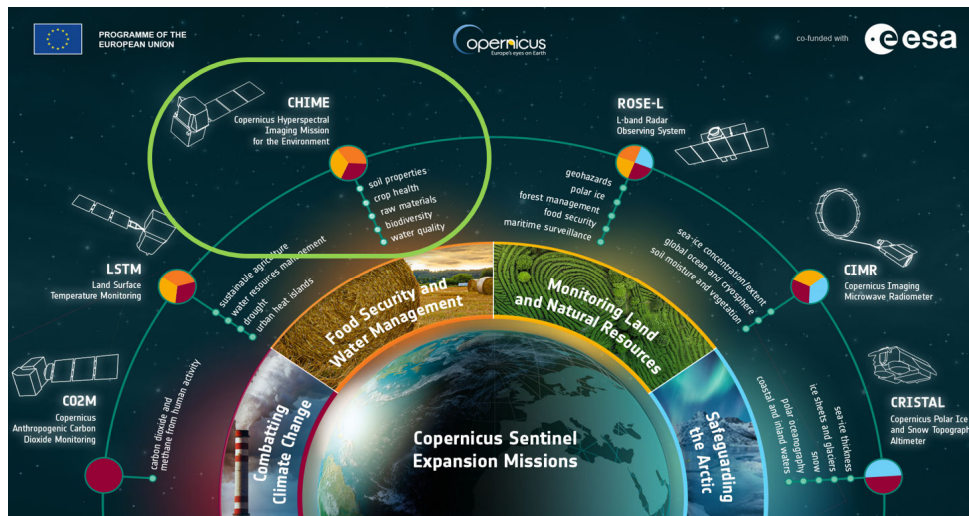
EnMAP – Summary and Outlook



- **Extensive scientific exploitation program**
 - Mission science support (EnMAP-Box, HYPERedu)
 - Synergy/complementarity with other hyperspectral missions
 - Cal/Val, supersites, reference datasets, standards and protocols
 - Involvement in next missions in preparation (e.g. CHIME)
 - Synergies with other hyperspectral missions

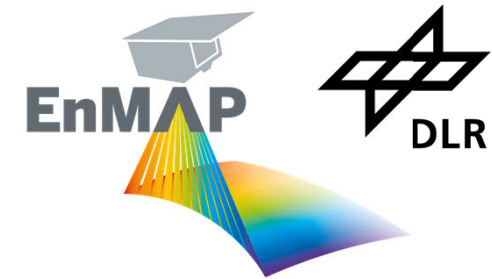


Session III „Hyperspectral VNIR/SWIR missions “



DOMAIN	THEMATIC AREA	VARIABLES CHPPP	CHIME Candidate Algorithms
AGRICULTURE / FOOD SECURITY	Assessment of biophysical and biochemical variables related to the crops and of agronomic interest	Leaf/Canopy Pigment Content	Semi-empirical modelling based on narrow-band vegetation indices; Hybrid methods based on ANN/LUT or other machine learning algorithms applied to vegetation canopy radiative transfer models outputs (e.g. PROSAIL).
		Leaf/Canopy Nitrogen Content	
	Topsoil properties	LAI	Narrow-band vegetation indices; Hybrid methods based on ANN/LUT or other machine learning algorithms e.g. GPR methods applied to vegetation canopy reflectance models (e.g. PROSAIL).
		Canopy Water Content	
GEOLOGY & MINERALS	Raw material detection	Leaf/Canopy Pigment Content	Chemometrics modelling (e.g. PLSR); Spectral analysis; Spectral indices; Machine learning (e.g. Random Forest)
		Leaf Mass/Area	
	Soil organic carbon content		
	Soil texture (clay, silt, sand)		
		Mineral identification / classification (Kaolinite, Smectite, Jarosite, Dolomite)	Sub-pixel linear unmixing Tetracorder type (EnGeoMap/PRISMA)
		Hematite – Goethite distribution	
		Ferric oxide content	
		Kaolin Crystallinity	

EnMAP



- **EnMAP – 1 year of data recording**
 - Data opened to the public since Nov. 2022, user community is growing
 - Exceptional data quality, Demonstration of high science application potential
- **EnMAP – User driven mission**
 - Acquisition request on demand, with mission capacity in mind
 - High demand of scheduled acquisition is being handled more efficiently in the future
- **EnMAP – User**
 - Team-up with other research groups
 - Have a look at the EnMAP archive
 - Request longer stripes and not only one tile
- **EnMAP – current information**
 - www.enmap.org
 - <https://planning.enmap.org/>

- Reprocessed data with significantly improved co-registration and geometric performance are being added to the EnMAP data archive. For best performance, it is recommended to use the latest version when more than one version of the product exists. Users should check the parameter "archivedVersion" where a version number equal or higher than 01.03.00 will identify a re-processed product (when an older version exists) or a newly created product.
- 15.06.2023: Introductory Videos on the use of the EnMAP Data Access Portal now online (see link Screenshot below).
- 15.05.2023: OR-SPC Planning Support Tool now supports submission of geographical coordinates by users.
- New document "Ordering Observation Requests" available as Link.
- User Manual extended by instructions on Proposal Submission and Ordering of Observation Requests.

