

# THREE YEARS OF ENMAP **GROUND SEGMENT OPERATIONS**



on the basis of a decision

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**German Aerospace Center (DLR)** 

2<sup>nd</sup> EnMAP User Workshop Munich, 02. April 2025

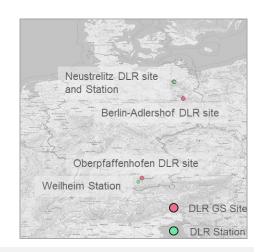




### The EnMAP Ground Segment

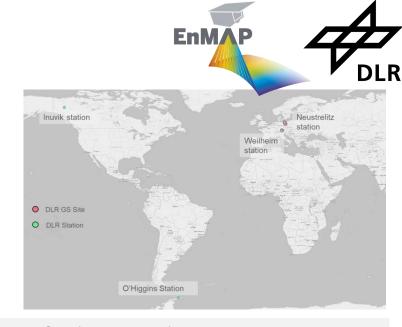
- DLR operates the EnMAP Ground Segment (GS), which is responsible for all EnMAP mission operations.
- Make sure the satellite operates correctly, receive observation requests, schedule observations, calibrate the instrument, process and deliver data products
- MOS (GSOC): mission operations, telecommands and telemetry, flight dynamics, mission planning



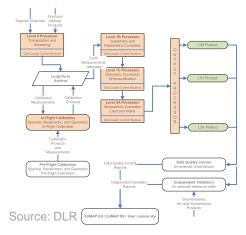


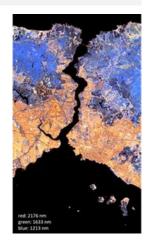
 PGS (DFD): data reception, processing, archiving and user interfaces for tasking and processing



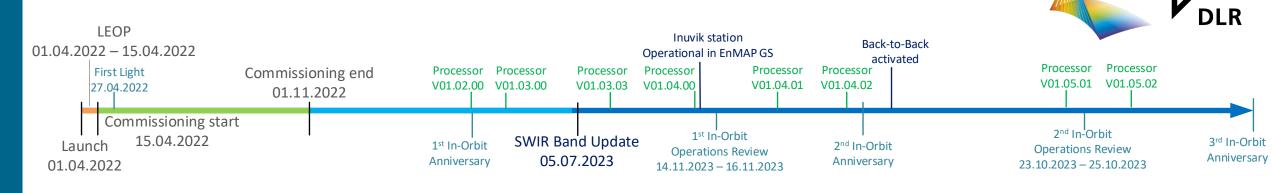


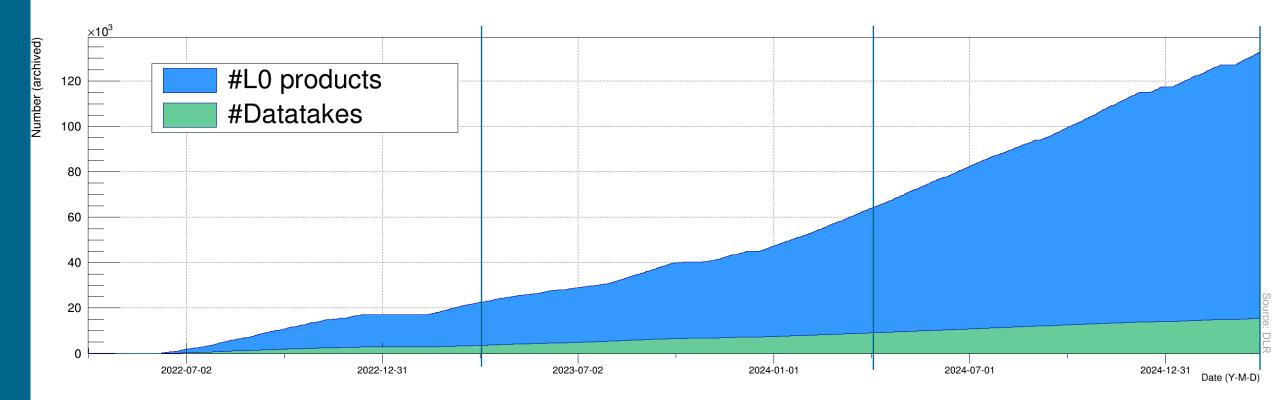
 PCV (IMF+DFD): processor maintenance, in-flight calibration, quality control and instrument monitoring





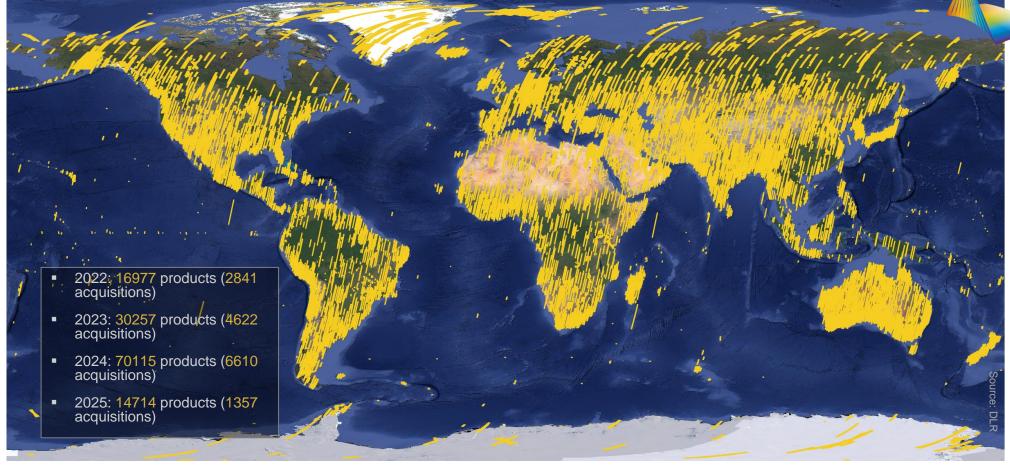
# **EnMAP Operations Timeline**





### **EnMAP 3 years of acquisitions**



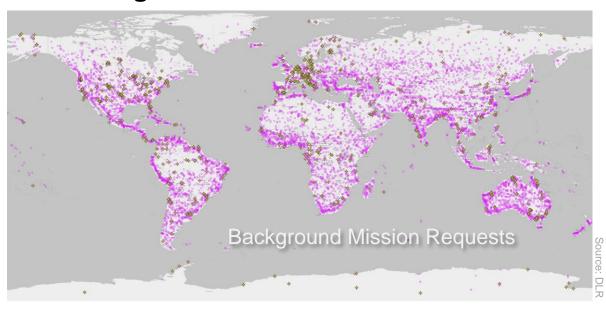


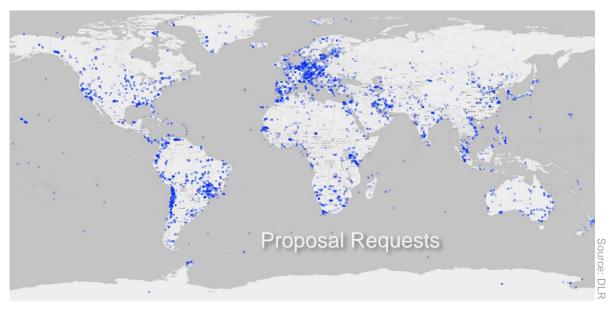
- More than 15400 Earth acquisitions
- More than 132000 Earth products archived and available for ordering at EOWEB
- 413 Calibrations (Sun, Deep Space, Lamp, Spectral, Linearity) and 7 Moon Observations

#### How is EnMAP tasked?



 Baseline: acquisitions entered by registered users. Quota and priority assigned upon proposal evaluation. Remaining time/space filled with lower priority acquisitions from the "Background Mission"





#### What is acquired?



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#### User requests introduce several challenges:

- Many short observations (80% of requests <= 3 tiles)</li>
- Some areas highly demanded, competition between users challenging (BG even less chances)
- No possibilities to prioritize a campaign

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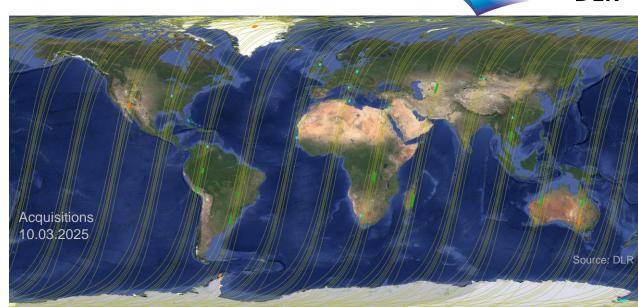
## **GS** Improvements for tasking

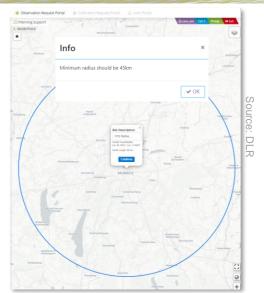


- Integration of Inuvik Station (Q4 2023): more flexible planning, free passages for image acquisition over Europe
- Introduction of Back-to-back imaging (April 2024): reduce distance between consecutive acquisitions (2750 km → ~700 km). Now, ~24% acquisitions in this mode



- Inhibition of ordering proposals with exhausted quota (activated 07.05.2024)
- Default off-nadir 30° → 15° (activated 07.02.2024)
- Restriction of acquisition time window (07.05.2024)
- No Re-do option because of clouds (31.01.2025)
- Minimum acquisition extension 1 tile (30 km) → 3 tiles (90 km) (activated 12.02.2025)
- Several usability improvements (landing portal, tooltips, ...)
- Soon: Proposal expiration date





#### **Foreground Mission**

- Introduced to compensate for inefficiencies identified with user acquisitions
- Highest priority acquisitions overriding any other acquisition requests
- Originally (2023) conceived to increase data acquired over Europe
- 2 4 monthly acquisitions. Concept proved successful
- Successfully used as well with certain field campaigns

#### 2024 and 2025 concept extended

- Series of flight lines agreed with user community that will be regularly observed by EnMAP
- Schedule of planned acquisitions available at:

https://www.enmap.org/data\_tools/foreground\_mission/



 Limitation between consecutive acquisitions creates an area where user acquisitions will have significantly less opportunities

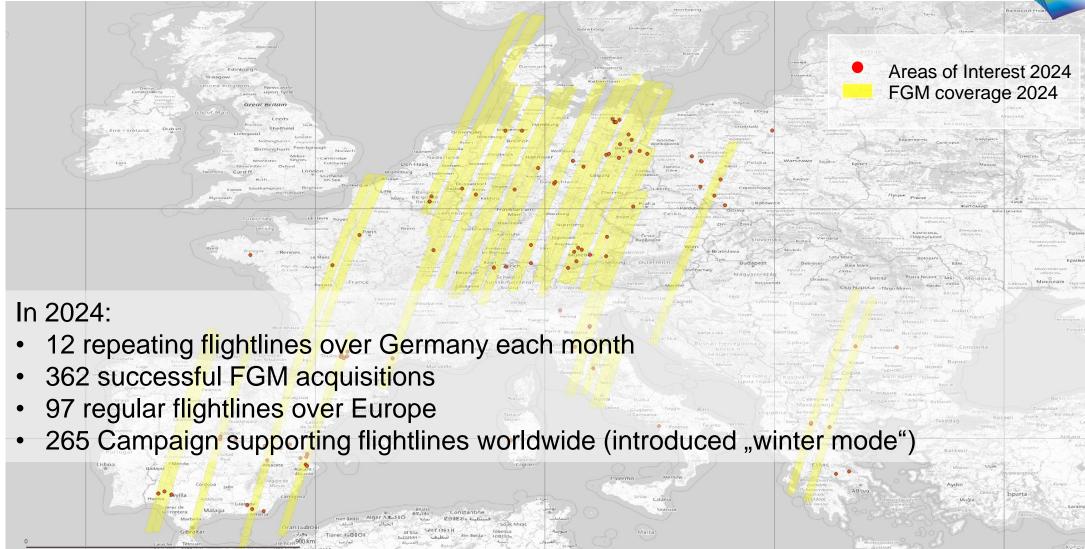


A collection of all planned acquisition strips can be found here; GeoJSO



					Leaflet   © C	© OpenStreefMap contributo	
ID	Date [M/D/Y], Time [UTC]	Center [Lat°, Lon°]	Duration [sec]	Off-Nadir Angle [°]	Pathdirection	Status	Data
52.0	10/3/2024, 10:40:31 AM	42.825, 12.579	48.974	2.778	descending	unplanned	GeoJSO
05.2	10/4/2024, 11:02:53 AM	50.667, 8.580	146.922	-1.096	descending	acquired	GeoJSO
41.0	10/5/2024, 11:29:12 AM	47.068, 1.143	146.922	0.881	descending	acquired	GeoJSO
31.0	10/5/2024, 11:31:26 AM	39.050, -2.100	146.922	-3.194	descending	unplanned	GeoJSO
50.0	10/7/2024, 10:41:51 AM	48.237, 12.821	146.922	-2.453	descending	acquired	GeoJSO
54.0	10/7/2024, 10:44:07 AM	43.139, 12.121	40.07	5.124	descending	unplanned	GeoJSO
07.2	10/8/2024, 11:06:32 AM	50.503, 7.847	146.922	0.345	descending	unplanned	GeoJSO
60.0	10/9/2024, 9:56:37 AM	41.698, 22.780	146.922	0.788	descending	acquired	GeoJSO
40.0	10/9/2024, 11:32:47 AM	47.115, 0.610	146.922	3.165	descending	unplanned	GeoJSO
30.0	10/9/2024, 11:34:38 AM	40.196, -0.032	146.922	15.523	descending	acquired	GeoJSO
17.2	10/11/2024, 10:44:44 AM	50.861, 13.288	146.922	-0.476	descending	acquired	GeoJSO
26.0	10/12/2024, 11:10:02 AM	50.965, 7.125	146.922	0.266	descending	unplanned	GeoJSO
61.0	10/13/2024, 10:00:08 AM	42.033, 22.061	146.922	1.329	descending	acquired	GeoJSO
25.0	10/15/2024, 10:48:16 AM	51.131, 12.898	146.922	1.897	descending	unplanned	GeoJSO
24.0	10/15/2024, 10:48:16 AM	51.178, 12.500	146.922	-0.583	descending	acquired	GeoJSO
29.0	10/16/2024, 11:12:47 AM	54.471, 7.580	133.565	-1.079	descending	unplanned	GeoJSO
22.0	10/16/2024, 11:13:36 AM	51.124, 6.485	146.922	1.428	descending	unplanned	GeoJSO
42.2	10/16/2024, 11:14:51 AM	46.611, 4.532	146.922	0.501	descending	acquired	GeoJSO
32.0	10/17/2024, 11:42:02 AM	40.072, -4.144	142.47	-0.527	descending	unplanned	GeoJSO
01.0	10/19/2024, 10:51:52 AM	51.262, 11.401	146.922	-1.948	descending	unplanned	GeoJSO
03.2	10/19/2024, 10:52:03 AM	50.563, 11.564	146.922	0.791	descending	acquired	GeoJSO
28.0	10/20/2024, 11:16:23 AM	54.158, 6.712	146.922	-0.046	descending	unplanned	GeoJSO
29.0	10/20/2024, 11:16:37 AM	53.220, 6.951	146.922	3.805	descending	acquired	GeoJSO

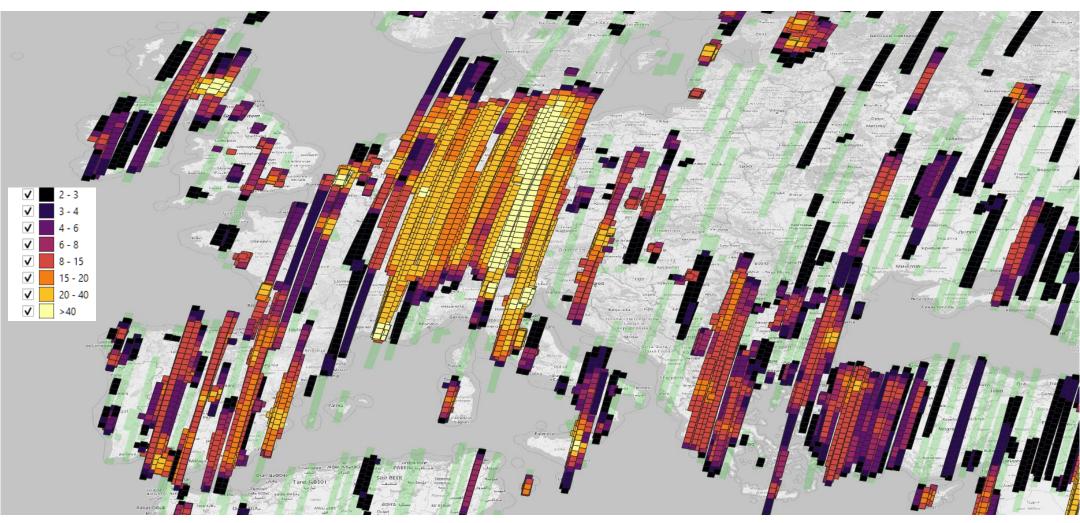






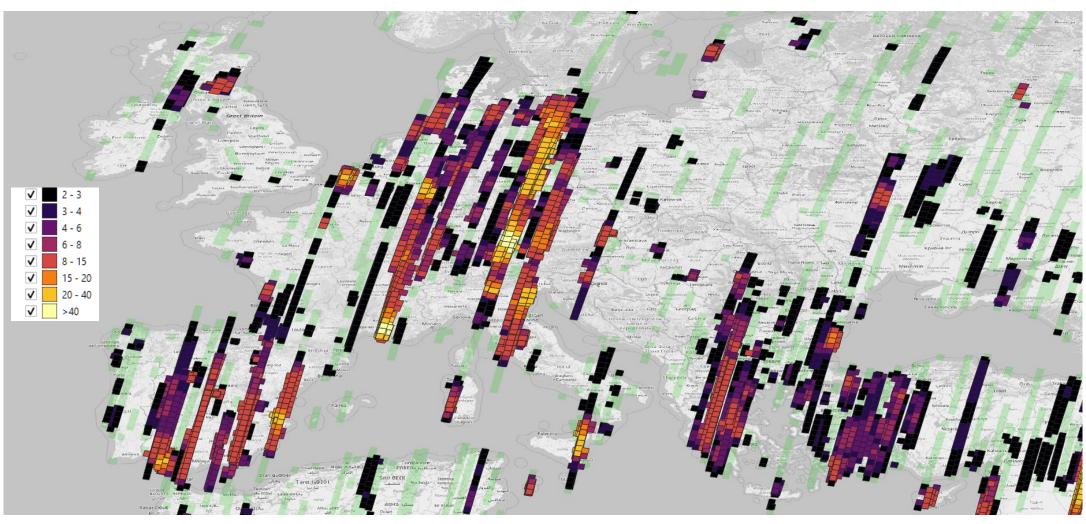
# Overlapping acquisitions (2 or more overlapping)

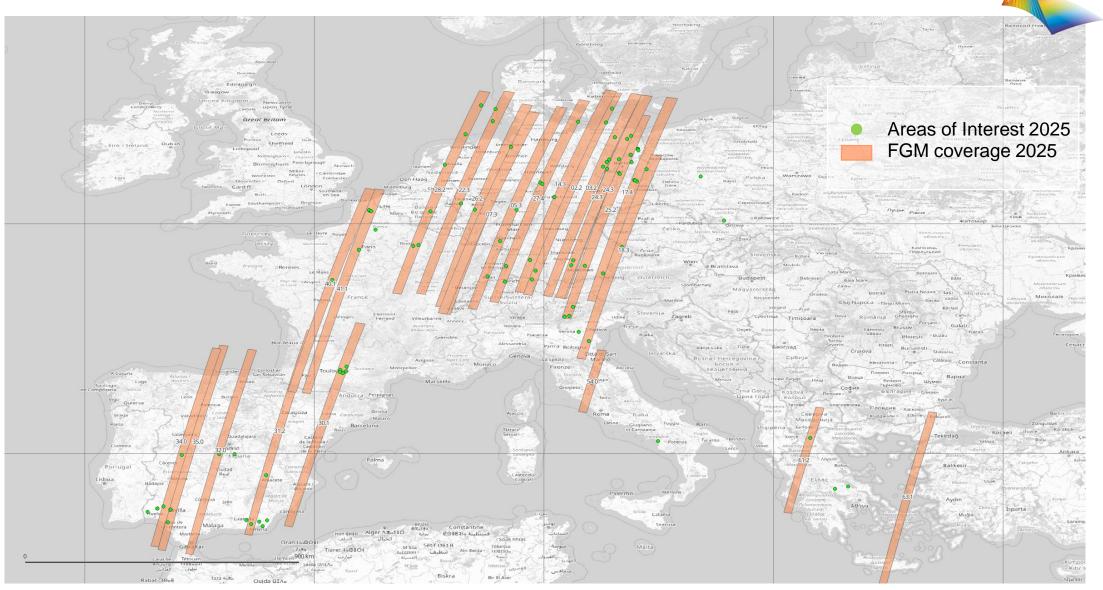




# Overlapping acquisitions (2 or more overlapping) < 20% clouds

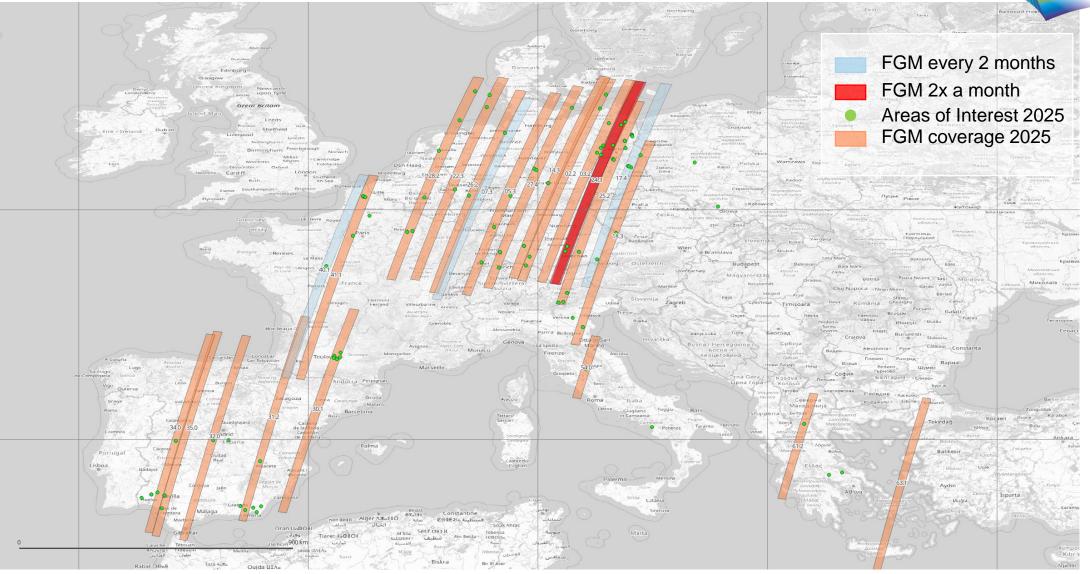






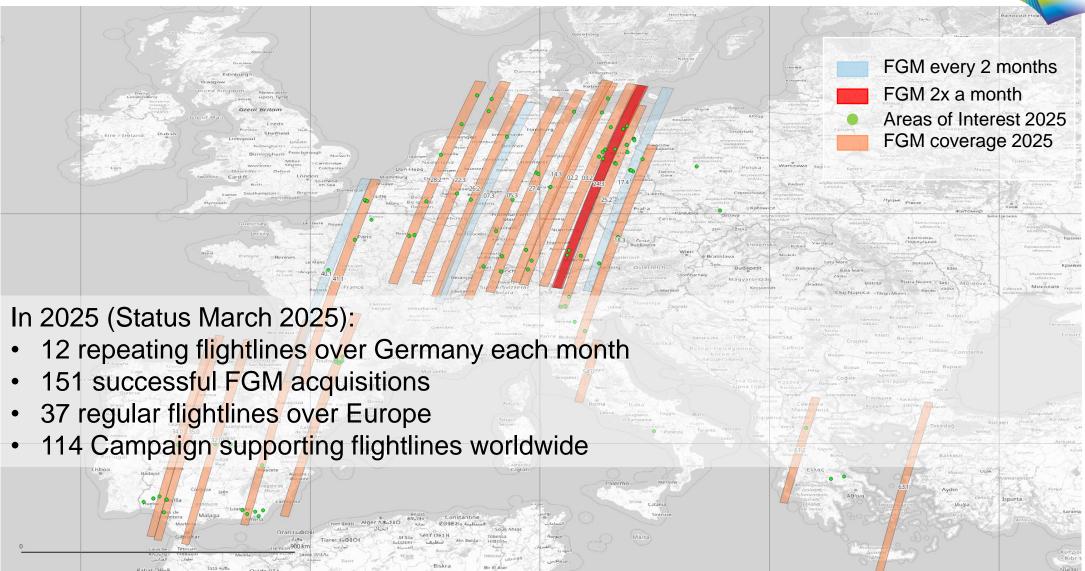






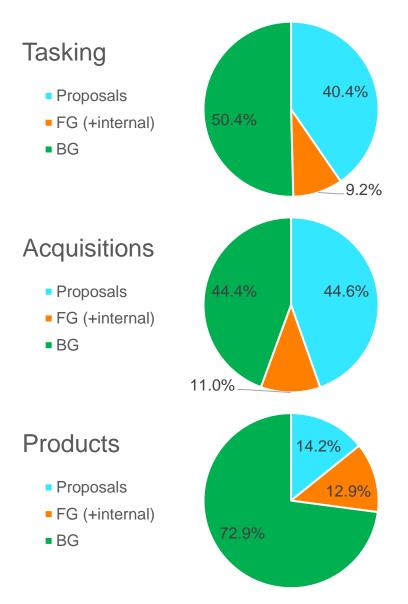


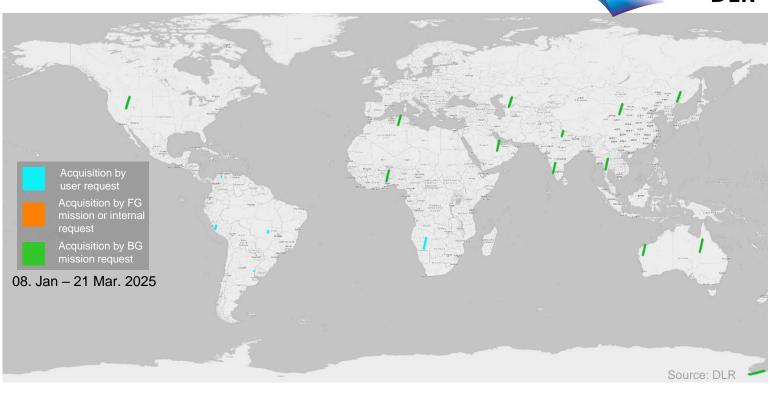






## Acquisitions after 3 years in operation





- There are 2.2 tasking requests to one proposal acquisition
- 47.1% success rate for user proposal requests (at least one EnMAP acquisition in the requested time window). 31.1% success rate with clouds < requested cloud limit</li>
- Your target could be covered by another request: always check the archive!

# **EnMAP** products and processing



#### Calibration

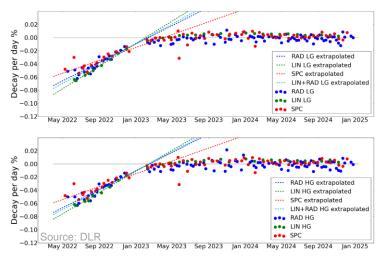
Very stable. Frequency of Sun calibration reduced to minimize diffuser degradation

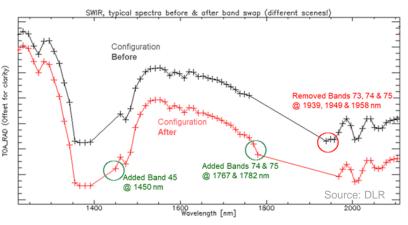
#### Radiometric/Spectral Data Quality

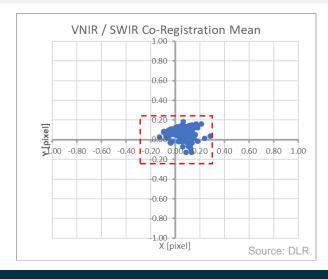
No issues and stable. Only remarkable change: SWIR update on 05.07.2023

#### **Geometric Data Quality**

Very good and stable. Excellent co-registration after re-processing the archived versions. Only latest version on EOWEB now



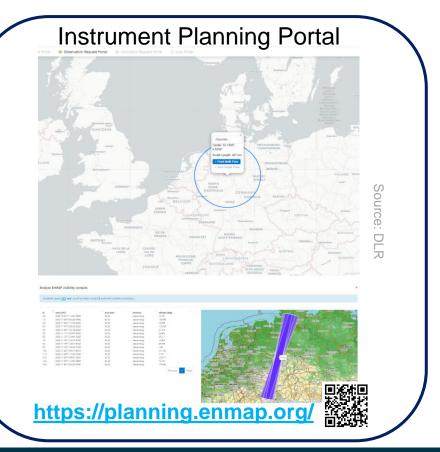




- 8 Processing chain version updates during Operational Phase (after end of commissioning phase)
- Check talk by M. Pato and Processor Changelog at <a href="https://www.enmap.org/data/doc/EnMAP\_processor\_changelog.pdf">https://www.enmap.org/data/doc/EnMAP\_processor\_changelog.pdf</a>
- Increased processing resources. Average processing time of a tasked product 3.2 days (97% < 6-days requirement)</li>

#### **EnMAP** data access



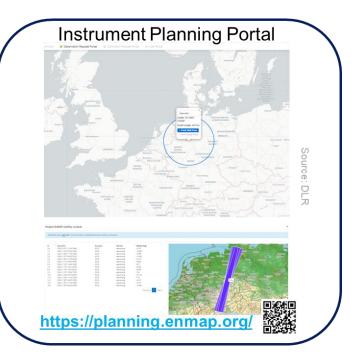


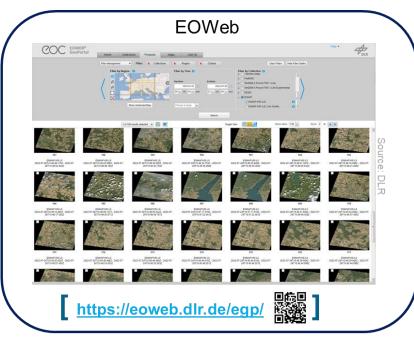


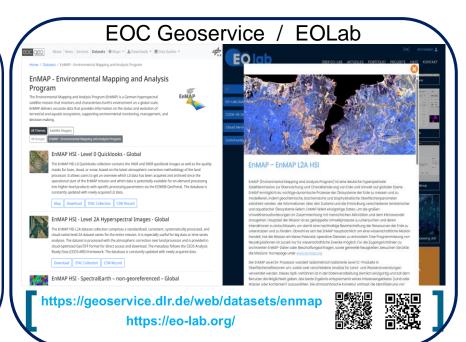
- Instrument planning portal used for user registration, proposal submission & tool to request EnMAP observations
- **EOWeb** provides interface to the mission archive for ordering products that will be **processed on-demand**

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- Instrument planning portal used for user registration, proposal submission & tool to request EnMAP observations
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- EOC GeoService / EOLab provide access to archived EnMAP L2A ARD already processed, with standard params.

#### **EnMAP** data access



#### Differences EOWEB - Geoservice



	EOWeb	Geoservice / EOLab
Access	Obtained after registration on EnMAP IPS portal	New registration required
Product provider	EnMAP GS	EnMAP GS
Availability	All archive	All archive* *only recently available full archive
Data download	FTP after on demand processing (several hours delay)	Direct download
Download Volume	20 products per order	Arbitrary number
Processor version	Always latest version	Different versions
Processing Options	User selectable	No options (fixed)
Product Types	L1B, L1C, L2A	Only L2A
Water processing	Yes	No
Product format	Geotiff, BIL, BIP, BSQ, JPEG2000	Cloud Optimized Geotiff (cog)
API	No	Yes. STAC support

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VNIR and SWIR quicklook images as well as the quality	ENMAP - ENMAP L2A HSI	2000
tmospheric correction methodology of the land data has been acquired and archived since the	ETIMAF - ETIMAF LZA HSI	4.0
ta is potentially available for on-demand processing	EnMAP (Environmental Mapping and Analysis Program) ist eine deutsche hyperspektrale	
rameters via the EOWEB-GeoPortal. The database is	Satelitenmission zur Überwachung und Charakterisierung von Erde und Umwelt auf globaler ErMAP ermöglicht es, wichtige dynamische Prozesse der Ökosysteme der Erde zu messen und	
	modellieren, indem geochemische, biochemische und biophysikalische Oberflächenparamel estrahiert werden, die Informationen über den Zustand und die Entwicklung verschiedener ter	
	und aquatischer Ökosysteme liefem. EnMAP liefert einzigartige Daten, um die großen	72
l Images - Global	Umweltherausforderungen im Zusammenhang mit menschlichen Aktivitäten und dem Klima anzugehen. Hauptziel der Mission ist es, gekoppelte Umweltprozesse zu untersuchen und dere	in.
andardized, consistent, systematically processed, and	Interaktionen zu entschlüsseln, um damit eine nachhaltige Bewirtschaftung der Ressourcen d unterstützen und zu fördern. Obwohl es sich bei EnMAP hauptsächlich um eine wissenschaftlic	
sion. It is especially useful for big data or time series eric correction over land processor and is provided in	handelt, hat die Mission ein klares Patenzial, operative Diensten zu entwickein. Eine Programm Neuakquisitionen ist zurzeit nur für wissenschoftliche Zwecke möglich. Für die Zugangsrichtlin	
d download. The metadata follows the CEOS Analysis constantly updated with newly acquired data.	archivierten EnMAP-Daten oder Beschaffungsanfragen, sowie generelle Neuigkeiten, besuche	
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	Der EnMAP Level ZA-Prozessor wandelt radiometrisch kallbrierte Level IC-Produkte in Oberflächenreflexionen um, wobei zwei verschiedene Ansätze für Land- und Wasseranwendu	ingen
eoreferenced - Global	verwendet werden. Dieses Spilt-Verfahren ist in der Datenverarbeitung ziemlich einzigartig un Benutzer die Möglichkeit geben, das beste Ergebnis entsprechend seines Interessengebietes	
en cici circui - dionai	Wasser oder kombiniert) auszuwählen. Die atmosphärische Korreitur umfasst die identifizien.	

https://eo-lab.org/

Instrument pla

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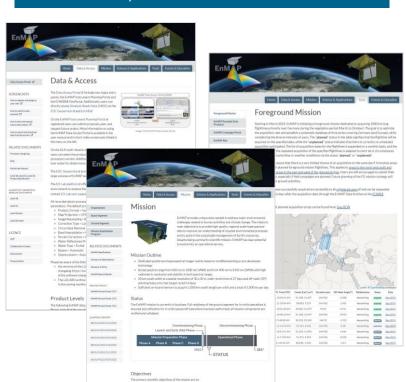
### Information about EnMAP operations



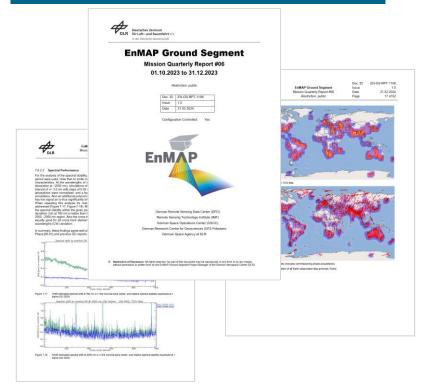
 News concerning operations published at the EnMAP Website



 Tutorials, ATBDs, FAQs, Ground Tracks, Example Data, MQRs, FG Mission, etc.



 Mission Quarterly Reports (MQRs) with detailed information about the mission status, calibration and data quality



All information available at www.enmap.org



- + Posters (by S. Baumann, N. Pinnel and M. Habermeyer)
- + Visit to Oberpfaffenhofen tomorrow

### In summary



- All systems operating correctly. No issues identified that could challenge operations, even beyond the initially planned 5 years
- The GS has introduced several updates during these 3 years in order to improve the operations. Specially on tasking experience, data quality and access
- Recommended to always check the archive. Even when your acquisition fails, there
  is a chance that it is covered by another acquisition, specially in case of Foreground
  Mission acquisitions
- Check <u>www.enmap.org</u> for information and news about the status of the EnMAP Mission



