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by the German Bundestag

THREE YEARS OF ENMAP GROUND SEGMENT OPERATIONS

E. Carmona, S. Baumann, S. Engelbrecht, M. Habermeyer, S. Hartung, L. La Porta, M. Pato,
N. Pinnel, D. Schulze, P. Schwind, K. Wirth and the EnMAP Ground Segment Team

German Aerospace Center (DLR)

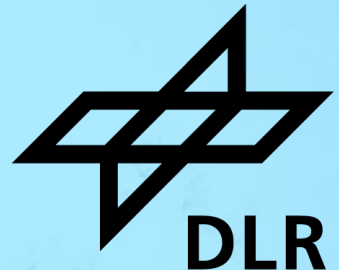
2nd EnMAP User Workshop
Munich, 02. April 2025



OHB

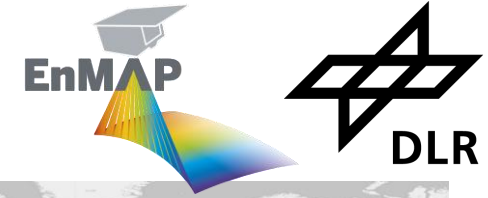


GFZ

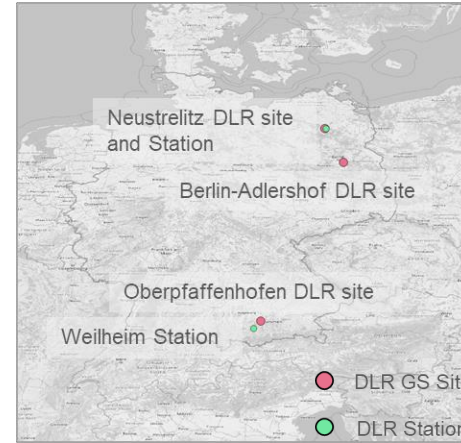


DLR

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

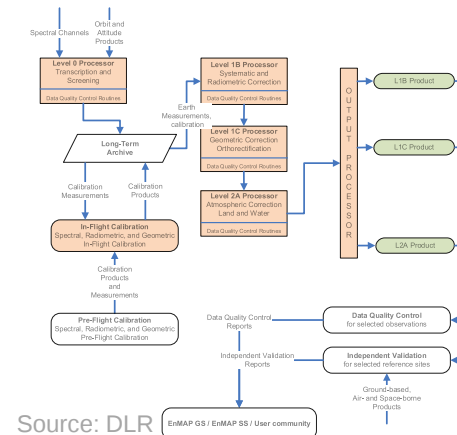
- **PCV (IMF+DFD)**: processor maintenance, in-flight calibration, quality control and instrument monitoring



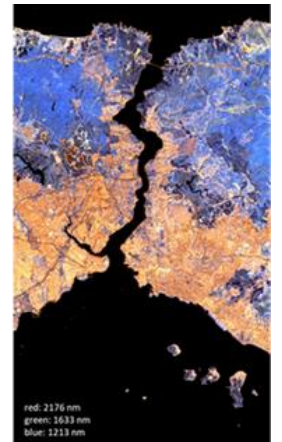
Source: DLR



Source: DLR

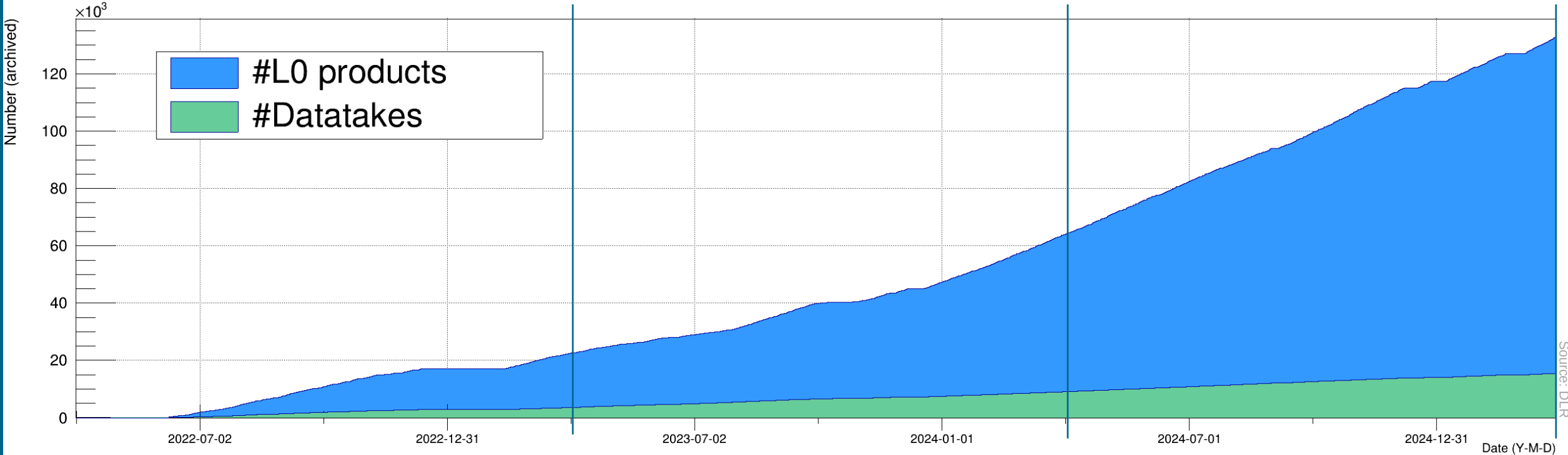
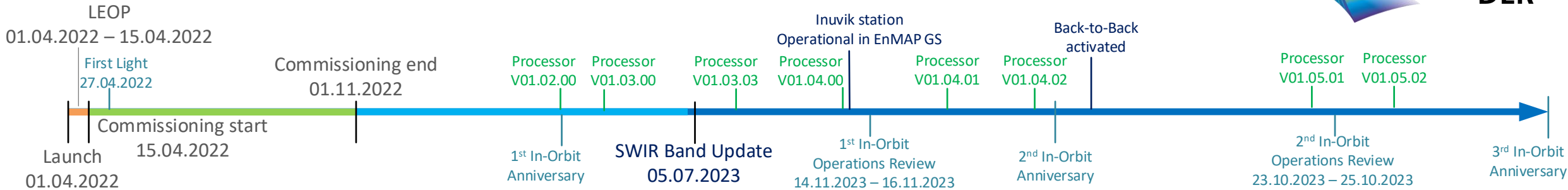
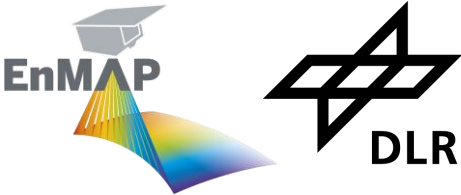


Source: DLR

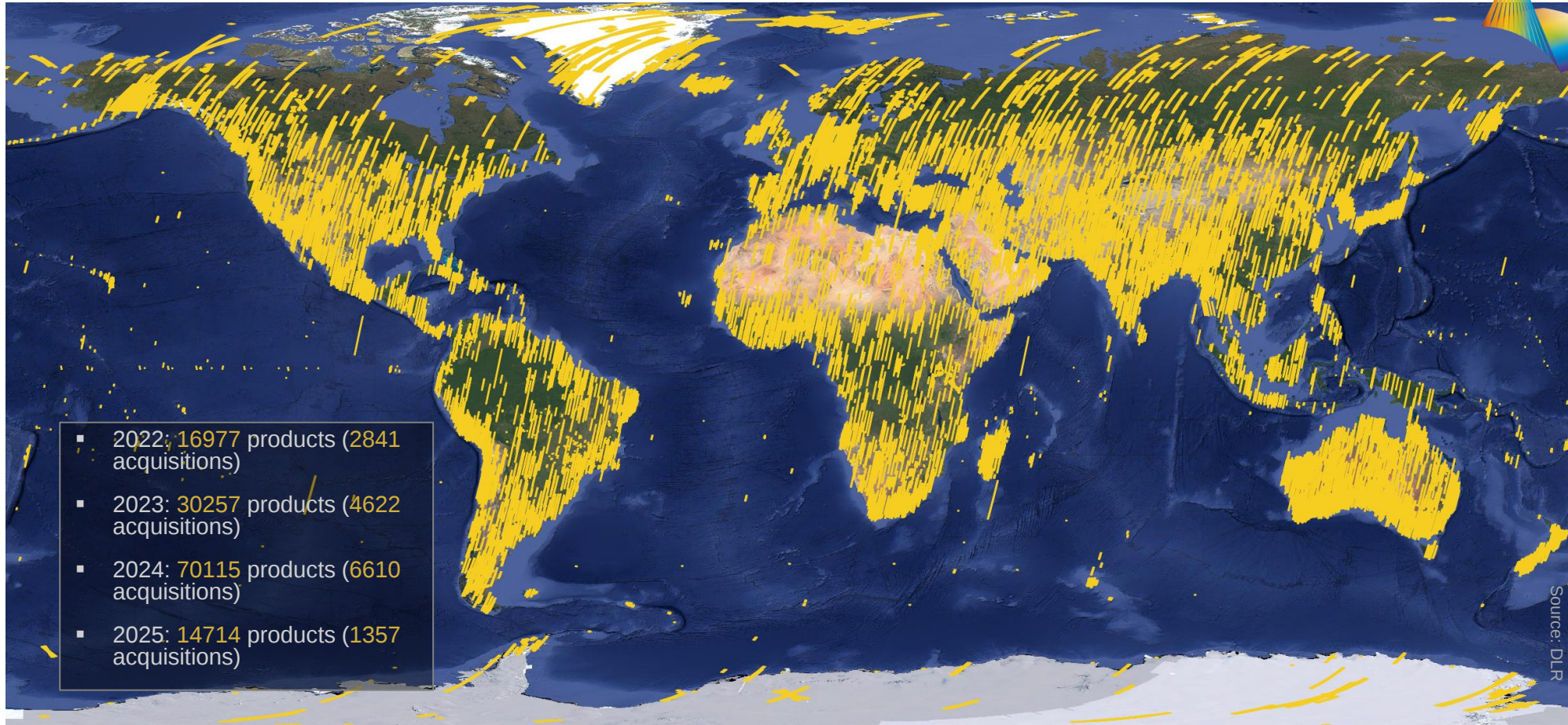
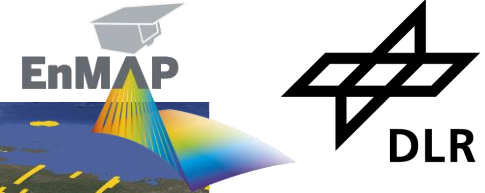


Source: DLR

EnMAP Operations Timeline

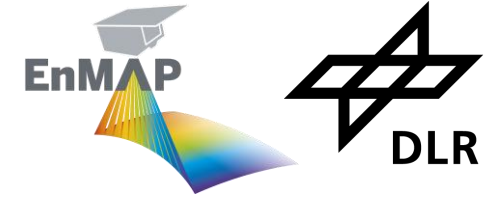


EnMAP 3 years of acquisitions

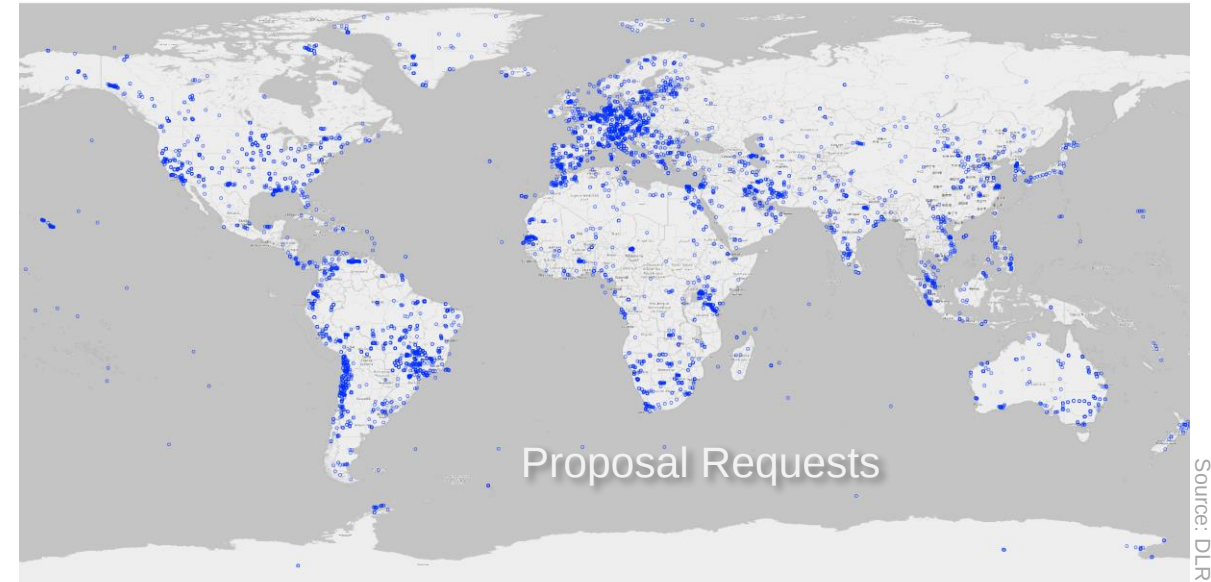
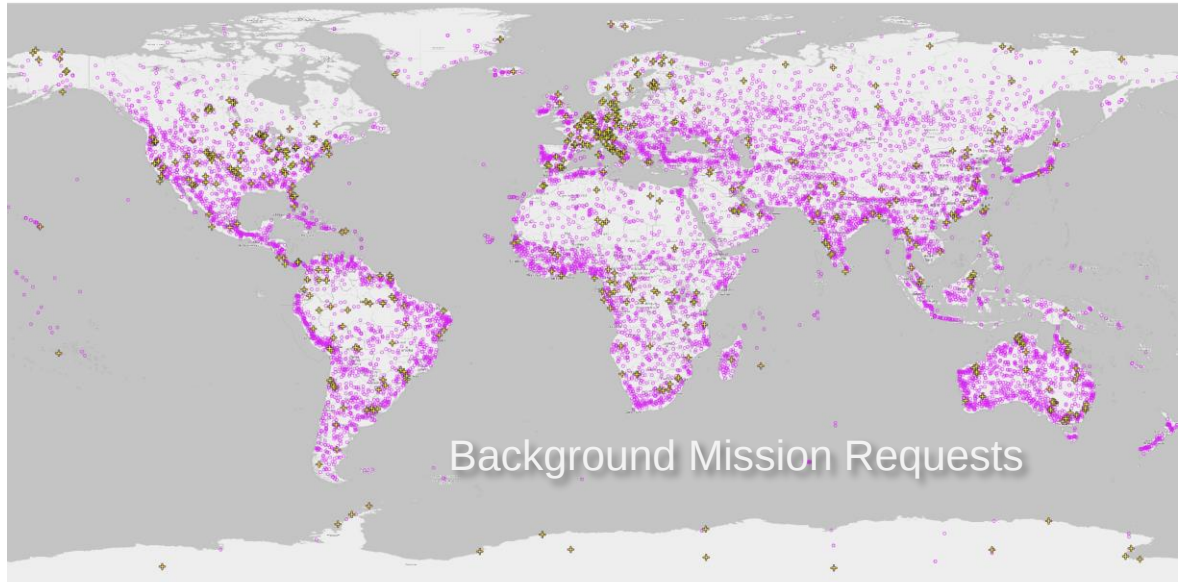


- More than 15400 Earth acquisitions
- More than 132000 Earth products archived and available for ordering at EOWEB
- 413 Calibrations (Sun, Deep Space, Lamp, Spectral, Linearity) and 7 Moon Observations

How is EnMAP tasked ?

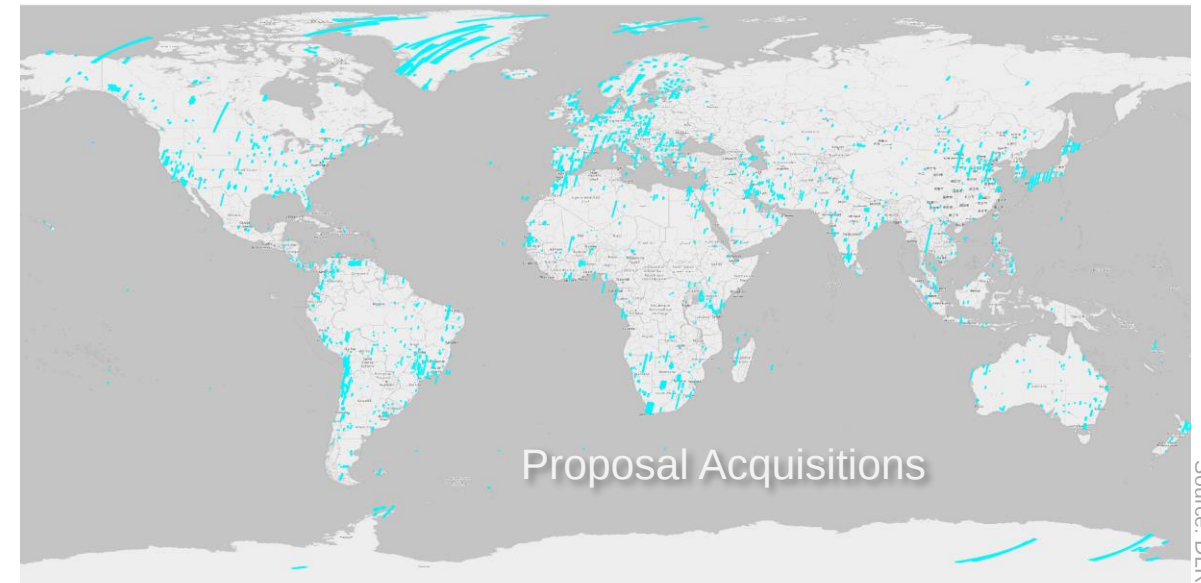


- Baseline: acquisitions entered by registered users. Quota and priority assigned upon proposal evaluation. Remaining time/space filled with lower priority acquisitions from the **“Background Mission”**



What is acquired?

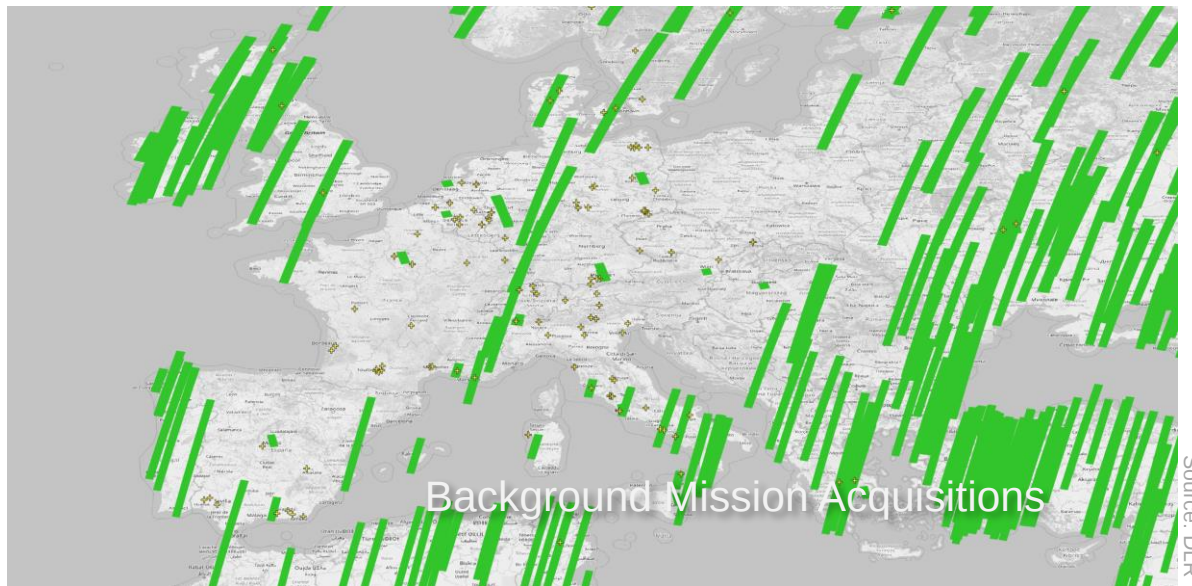
- Baseline: acquisitions entered by registered users. Quota and priority assigned upon proposal evaluation. Remaining time/space filled with lower priority acquisitions from the **“Background Mission”**



- **User requests introduce several challenges:**
 - Many short observations (80% of requests ≤ 3 tiles)
 - Some areas highly demanded, competition between users challenging (BG even less chances)
 - No possibilities to prioritize a campaign

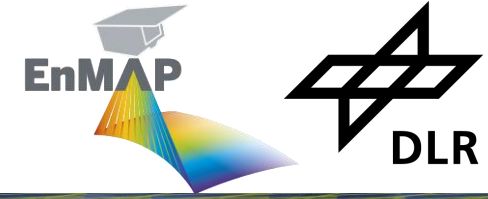
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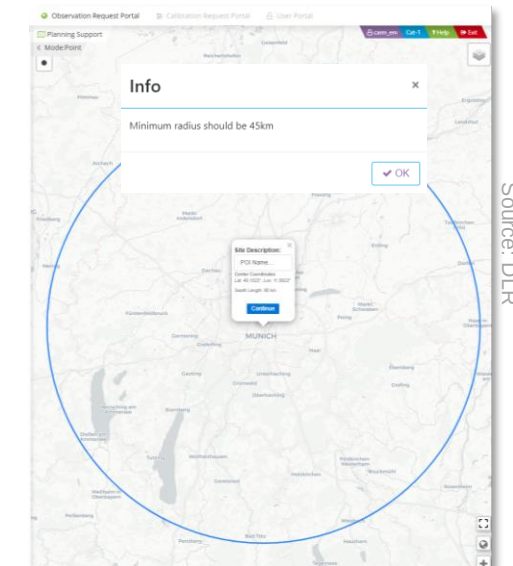
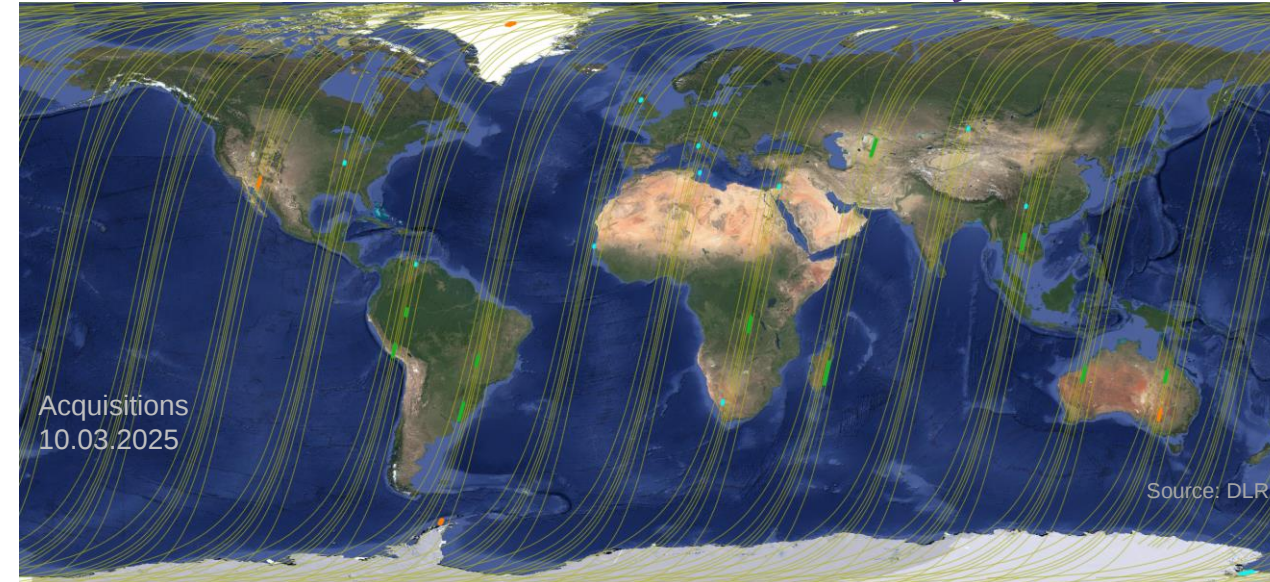


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GS Improvements for tasking



- 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 $\rightarrow$ ~700 km). Now, ~24% acquisitions in this mode
- Changes in Planning System:
 - Inhibition of ordering proposals with exhausted quota (activated 07.05.2024)
 - Default off-nadir $30^\circ \rightarrow 15^\circ$ (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) $\rightarrow$ 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

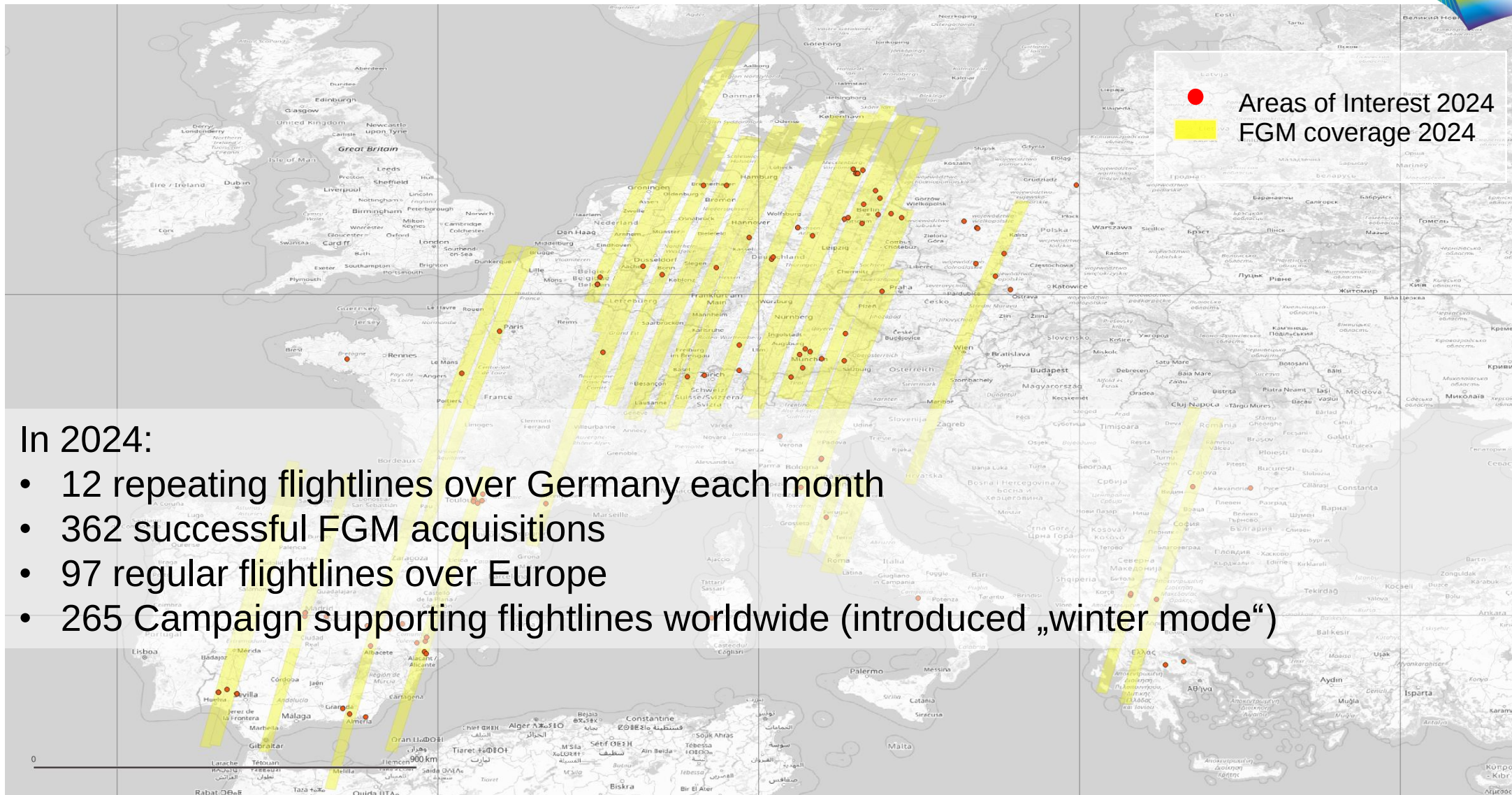
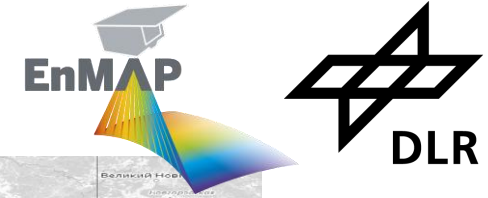


A collection of all planned acquisition strips can be found here: [GeoJSON](#)

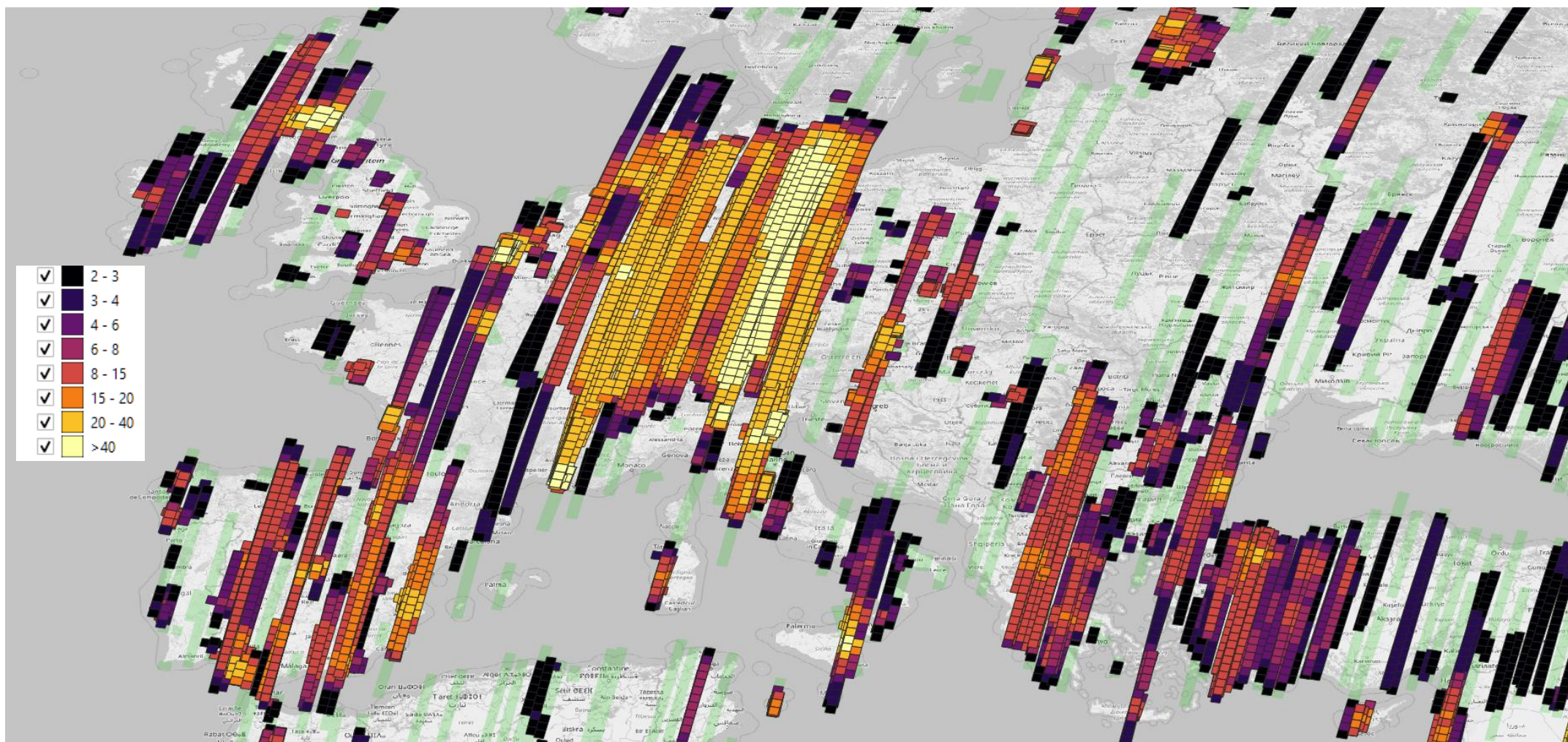
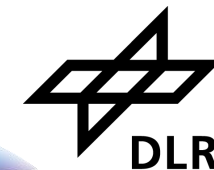
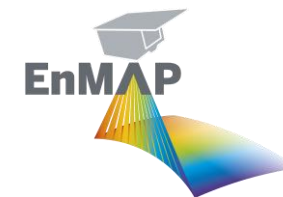


ID	Date [M/D/Y], Time [UTC]	Center [Lat°, Lon°]	Duration [sec]	Off-Nadir Angle [°]	Path direction	Status	Data
52.0	10/3/2024, 10:40:31 AM	42.825, 12.579	48.974	2.778	descending	unplanned	GeoJSON
05.2	10/4/2024, 11:02:53 AM	50.667, 8.580	146.922	-1.096	descending	acquired	GeoJSON
41.0	10/5/2024, 11:29:12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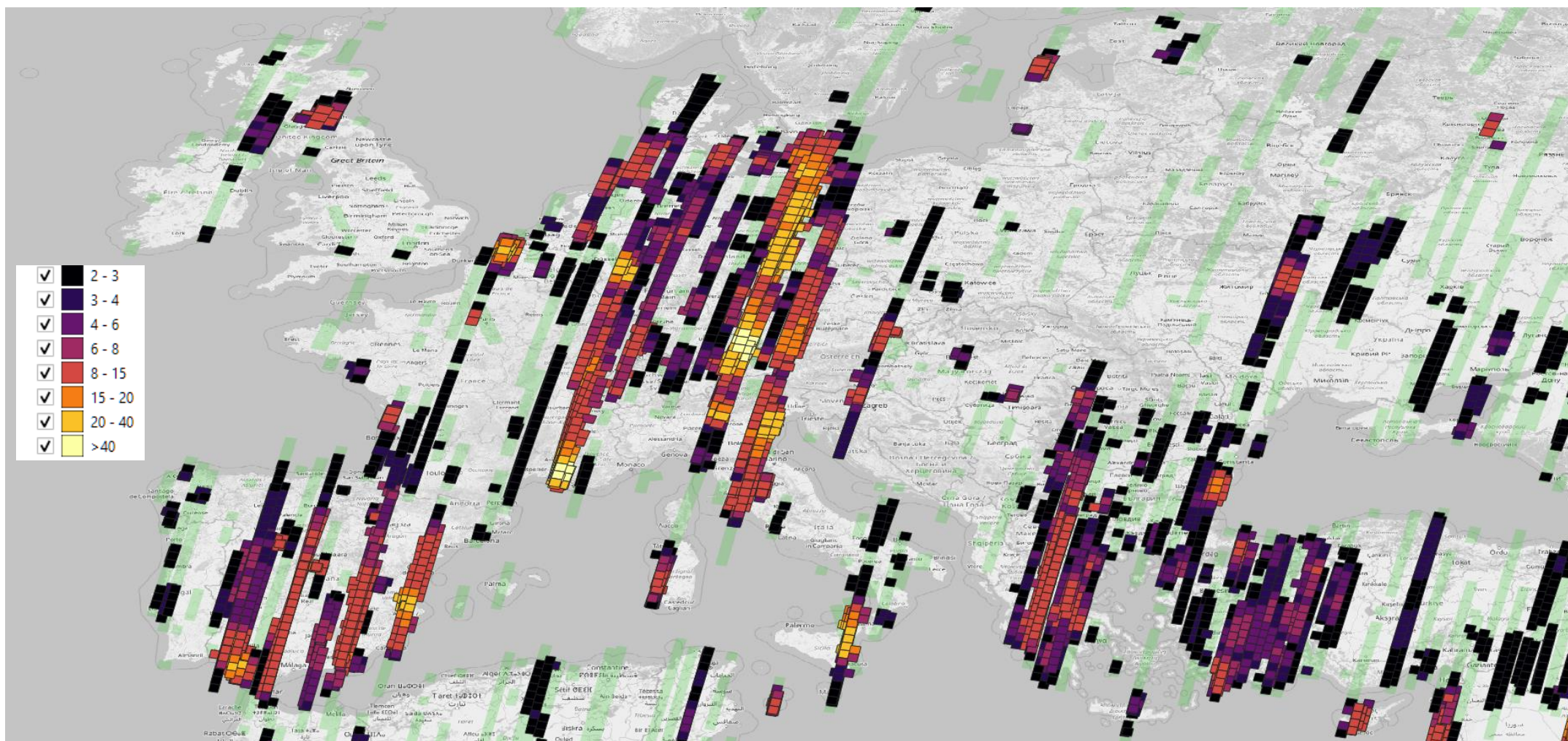
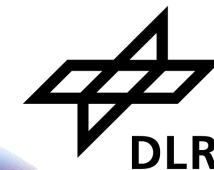
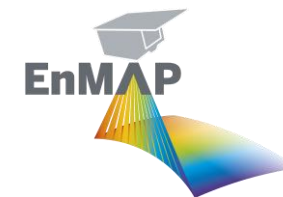
Foreground Mission Plan 2024



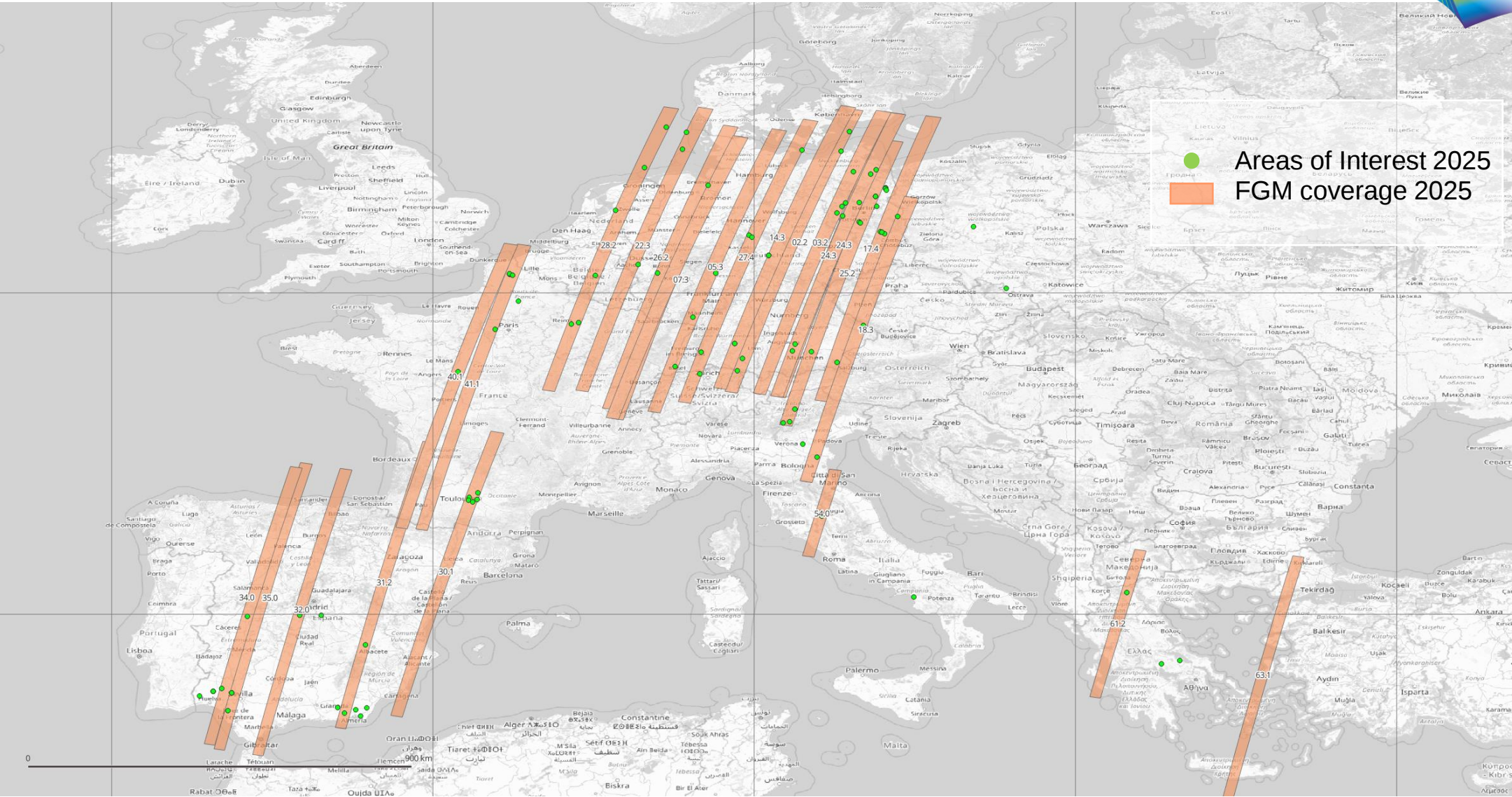
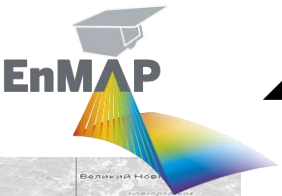
Overlapping acquisitions (2 or more overlapping)



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

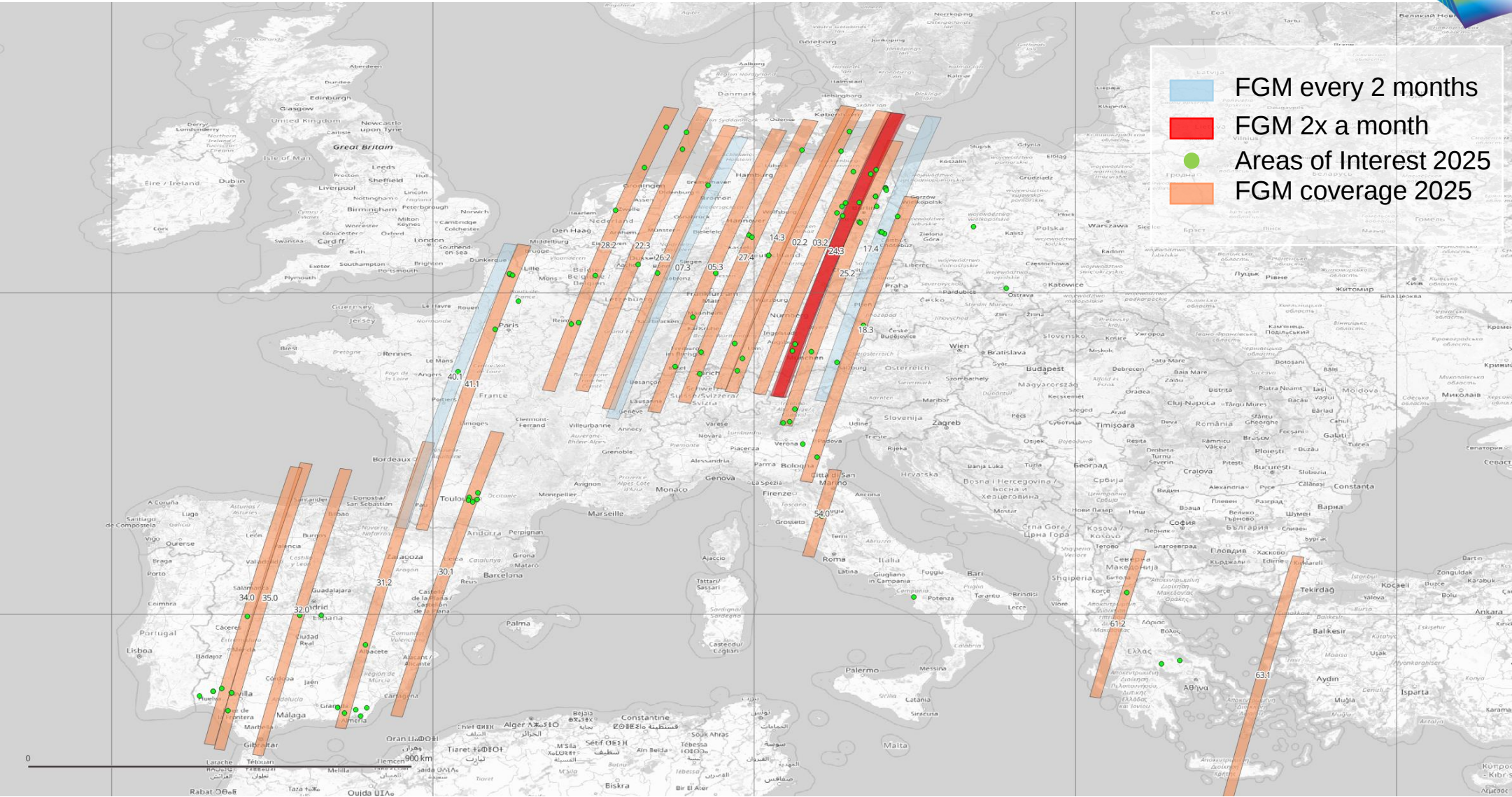
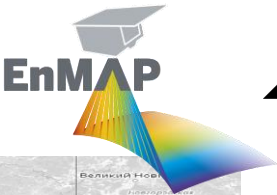


Foreground Mission Plan 2025



https://www.enmap.org/data_tools/foreground_mission/

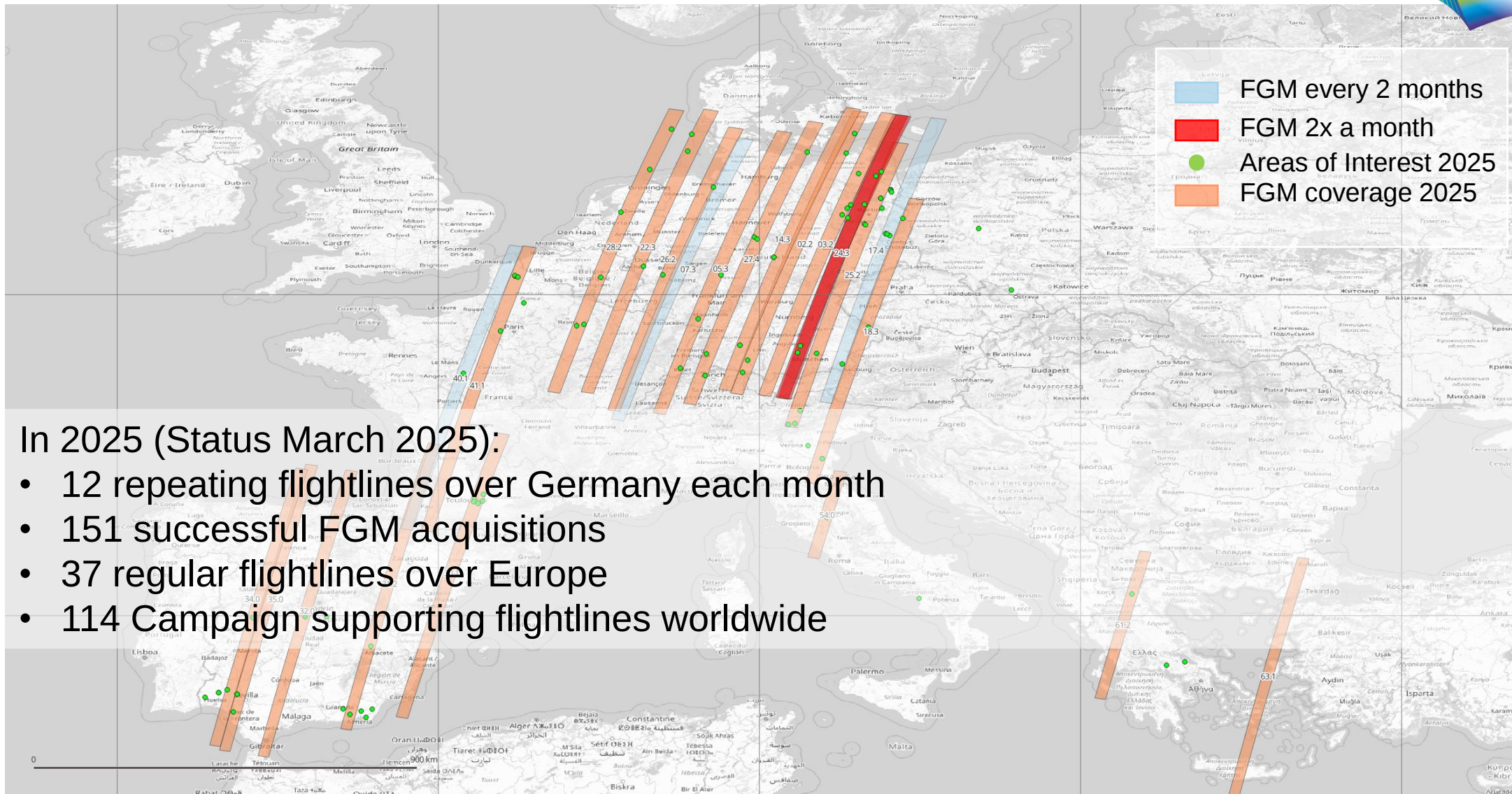
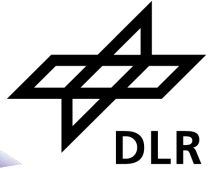
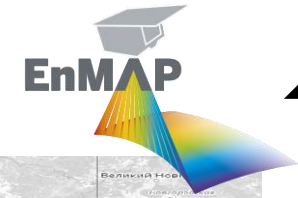
Foreground Mission Plan 2025



https://www.enmap.org/data_tools/foreground_mission/



Foreground Mission Plan 2025



In 2025 (Status March 2025):

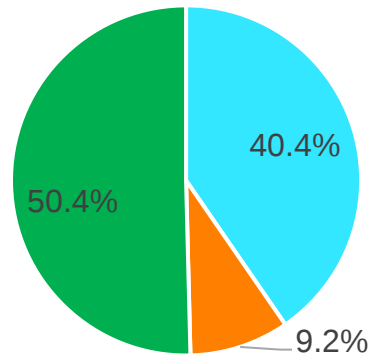
- 12 repeating flightlines over Germany each month
- 151 successful FGM acquisitions
- 37 regular flightlines over Europe
- 114 Campaign supporting flightlines worldwide



Acquisitions after 3 years in operation

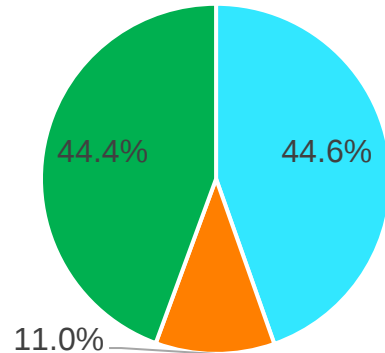
Tasking

- Proposals
- FG (+internal)
- BG



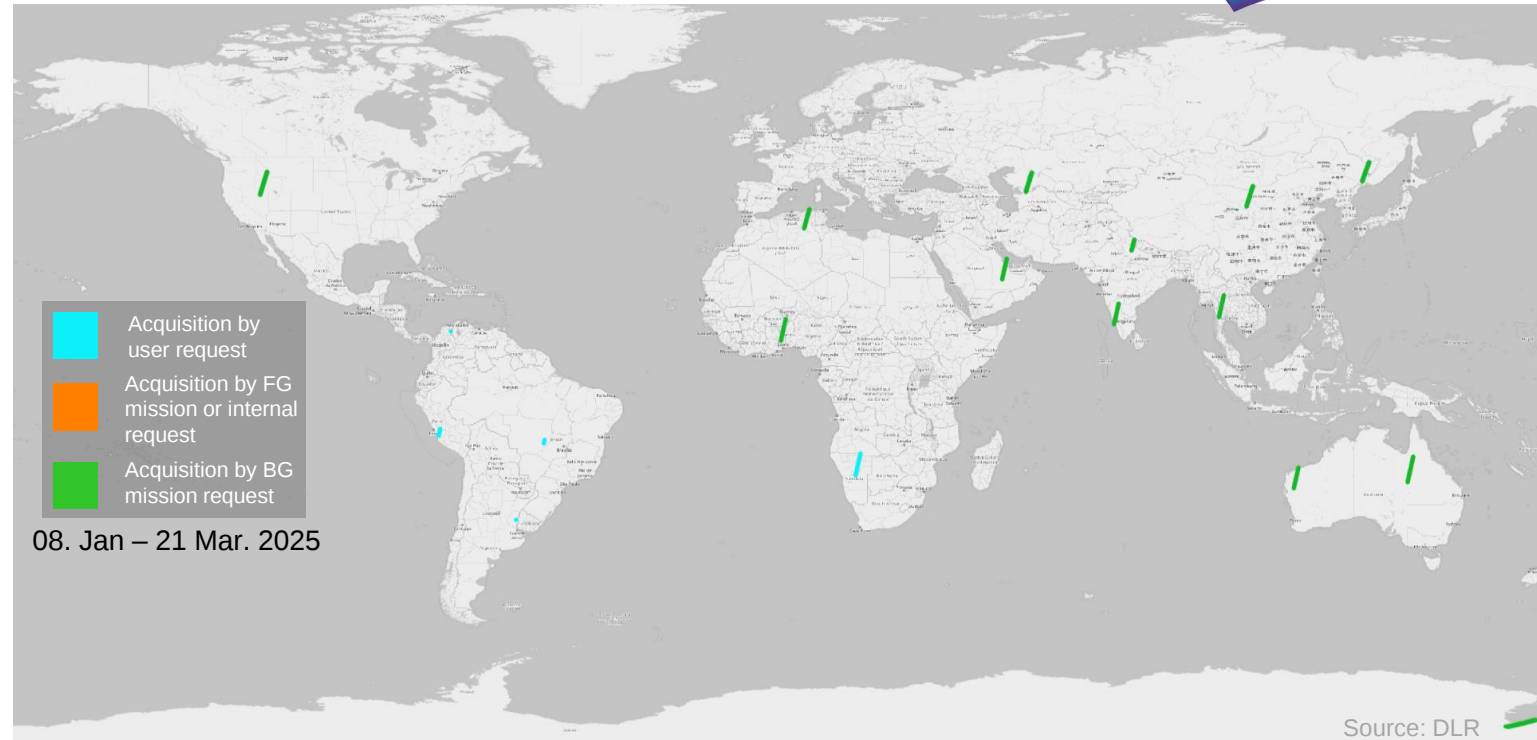
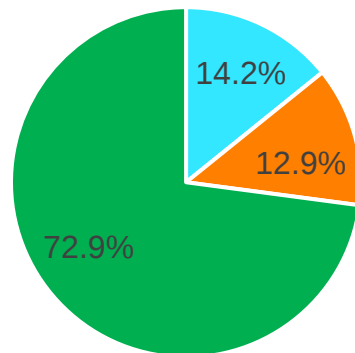
Acquisitions

- Proposals
- FG (+internal)
- BG



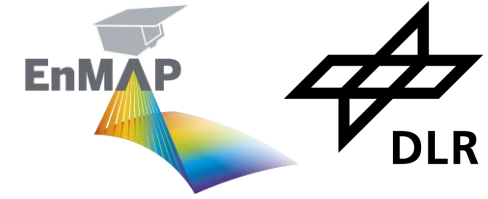
Products

- Proposals
- FG (+internal)
- BG



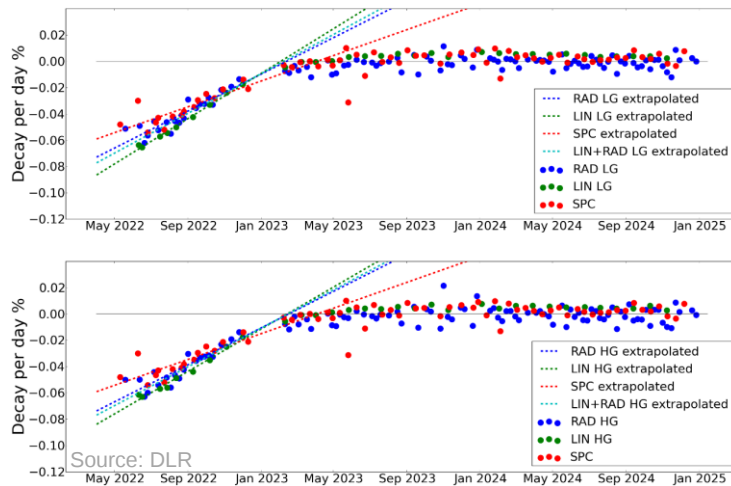
- There are 2.2 tasking requests to one proposal acquisition
- 47.1% success rate for user proposal requests (at least one EnMAP acquisition in the requested time window). 31.1% success rate with clouds < requested cloud limit
- Your target could be covered by another request: **always check the archive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

EnMAP products and processing



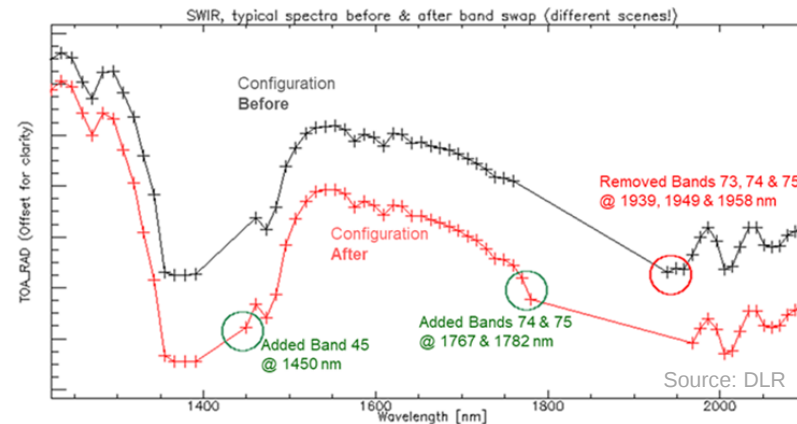
Calibration

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



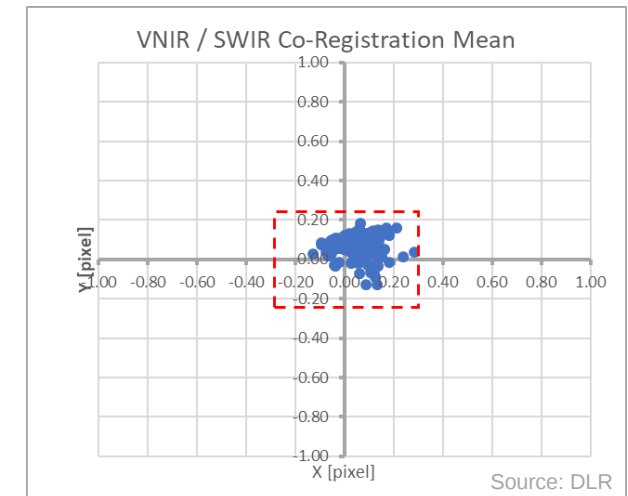
Radiometric/Spectral Data Quality

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



Geometric Data Quality

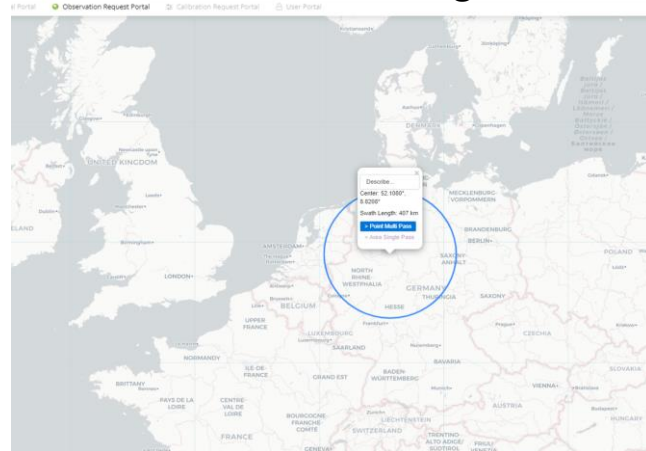
Very good and stable. Excellent co-registration after re-processing the archived versions. Only latest version on EOWEB now



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

EnMAP data access

Instrument Planning Portal

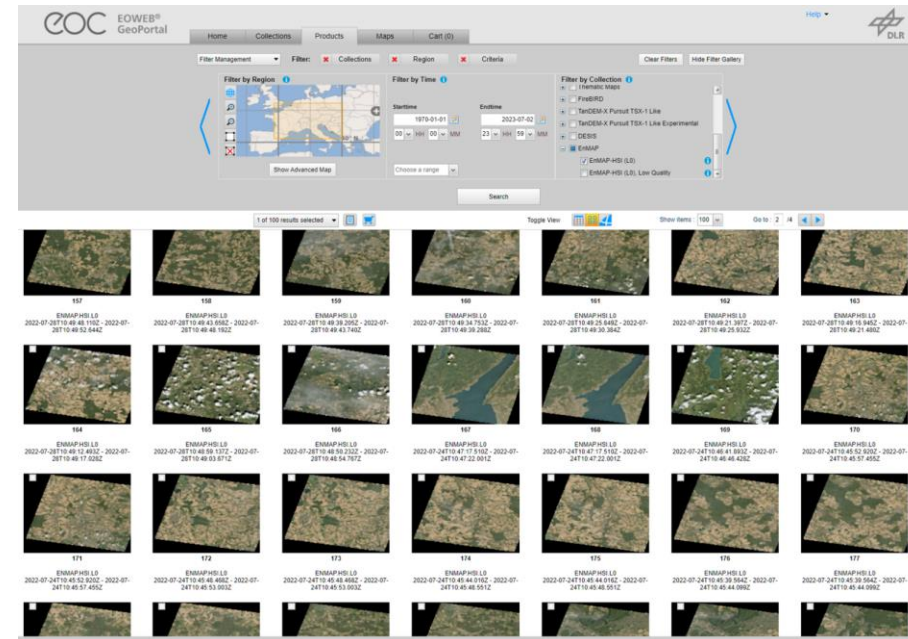


Source: DLR

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



EOWeb



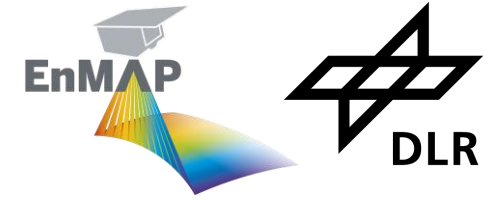
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[<https://eoweb.dlr.de/egp/>]

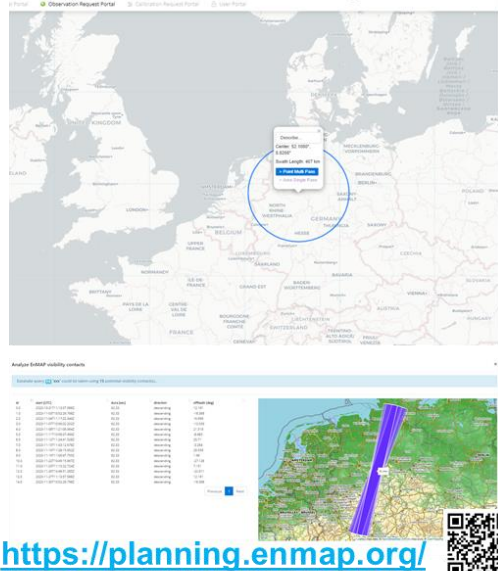


- **Instrument planning portal** used for user registration, proposal submission & tool to request EnMAP observations
- **EOWeb** provides interface to the mission archive for ordering products that will be **processed on-demand**

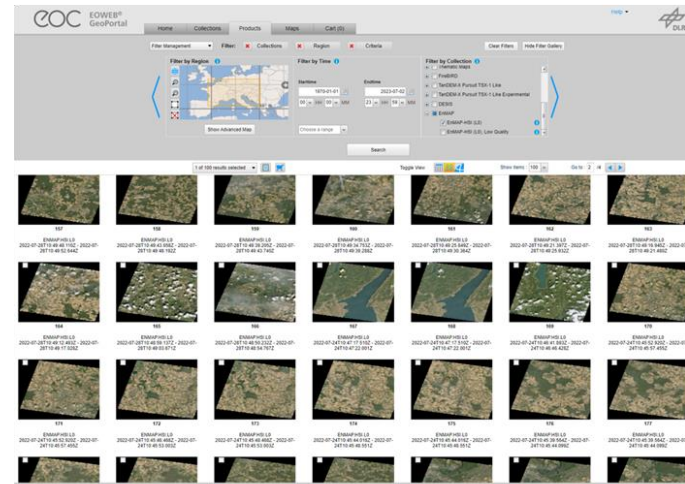
EnMAP data access



Instrument Planning Portal



EOWeb



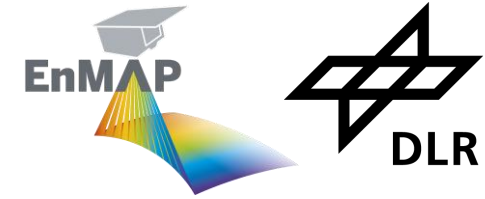
<https://eoweb.dlr.de/egg/>

EOC Geoservice / EOlab



- **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**
- **EOC GeoService / EOlab** provide access to archived EnMAP **L2A ARD already processed**, with standard params.

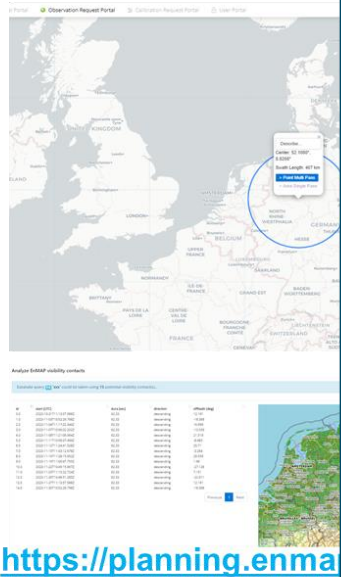
EnMAP data access



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

Instrument Planning

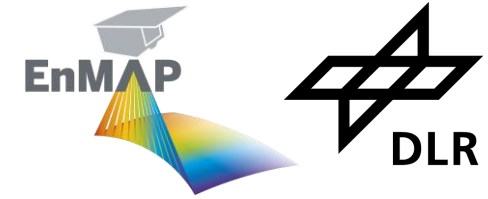


EOC Geoservice / EOlab



- Instrument planning
- EOWeb provides access to archived EnMAP L2A ARD already processed, with standard params.
- EOC GeoService / EOlab provide access to archived EnMAP L2A ARD already processed, with standard params.

Information about EnMAP operations



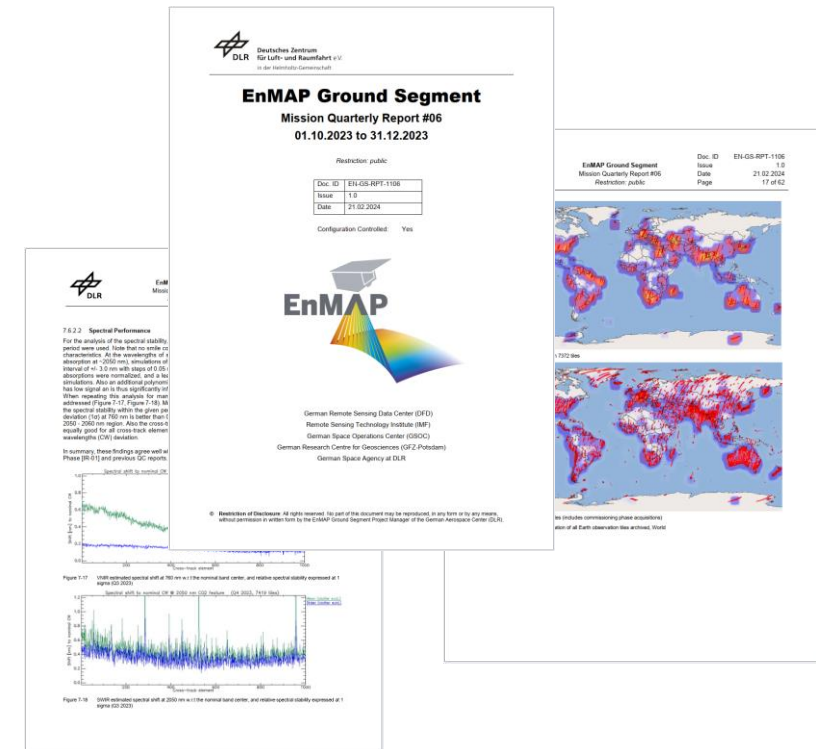
- News concerning operations published at the EnMAP Website



- 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

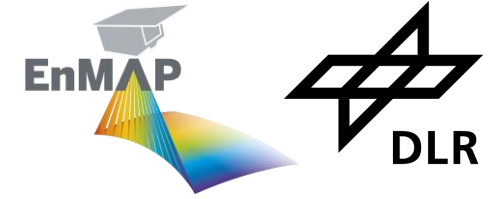


- All information available at www.enmap.org



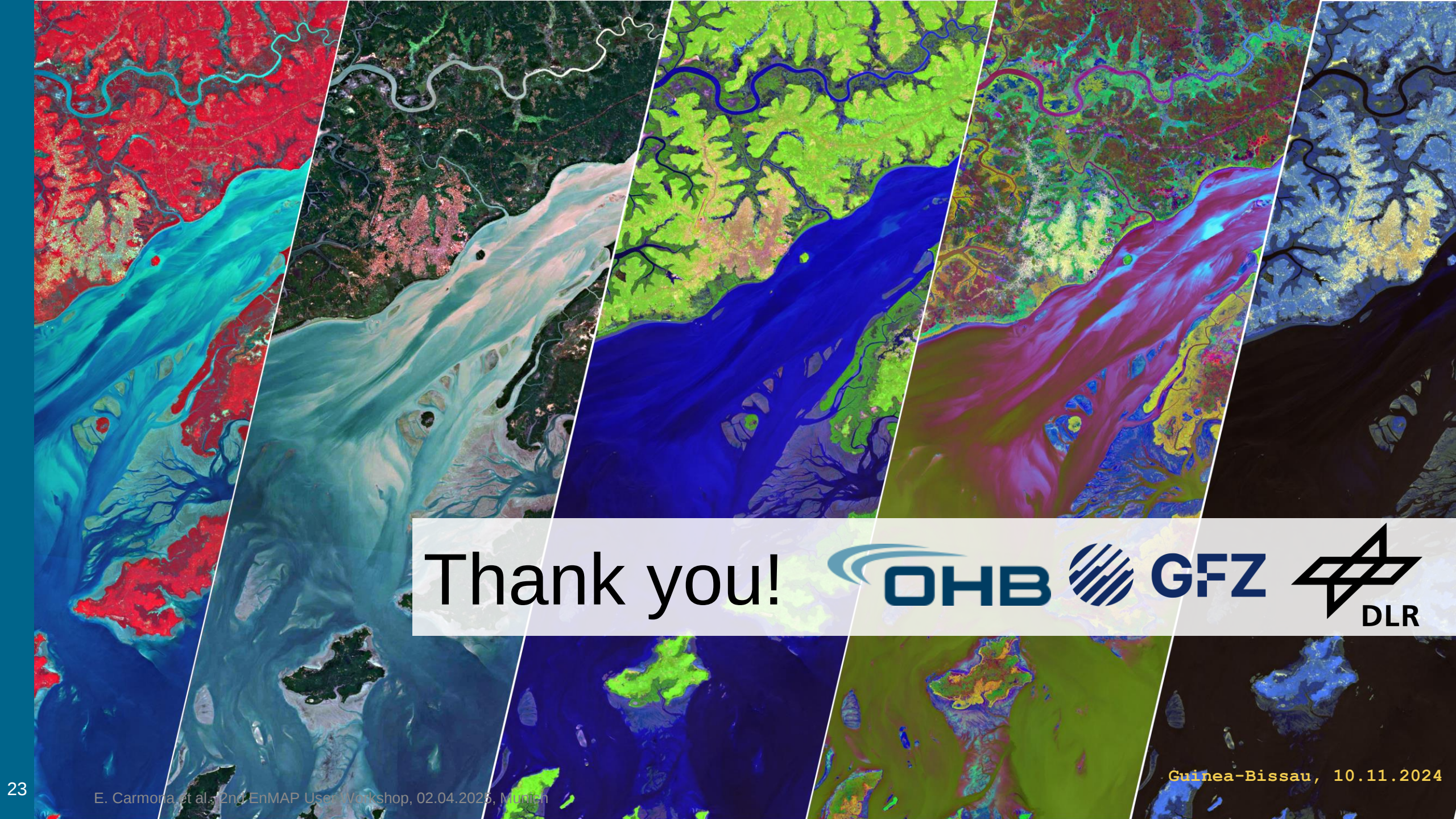
+ Posters (by S. Baumann, N. Pinnel and M. Habermeyer)
+ Visit to Oberpfaffenhofen tomorrow

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 www.enmap.org for information and news about the status of the EnMAP Mission





Thank you!



Guinea-Bissau, 10.11.2024