The EnMAP in commissioning: Mission status and update

Sabine Chabrillat (1,2), Sebastian Fischer (3),Tobias Storch (4), Karl Segl (1), Saskia Foerster (1), Maximilian Brell (1), Luis Guanter (5), Anke Schickling (3), Hans-Peter Honold (6)

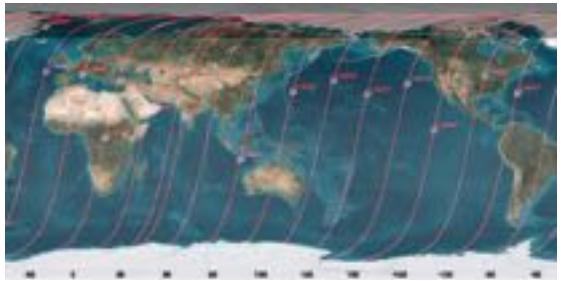
And the whole EnMAP team

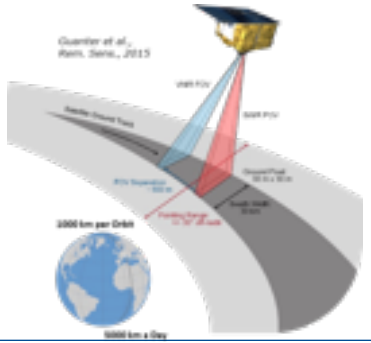
(1) Helmholtz Center Potsdam, GFZ German Research Center for Geosciences, Potsdam, Germany
(2) Leibniz University Hannover (LUH), Institute of Soil Science, Hannover
(3) German Space Agency, German Aerospace Center (DLR), Bonn
(4) Earth Observation Center (EOC), German Aerospace Center (DLR), Weßling, Germany
(5) Universitat Politècnica de València, Valencia, Spain
(6) OHB System AG, Weßling, Germany

Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag

EnMAP: A new sensor for monitoring Earth's environment

- **Core themes**: Environmental changes, ecosystem responses to human activities, management of natural resources
- **Core parameters**: Global coverage, 30m pixel size, 242 spectral channels, revisit 27 days nadir, 4 days off-nadir tilting, scientific mission
  - Measurements of **key biophysical and geochemical parameters**
  - **Highly calibrated** imaging spectroscopy data
  - **Co-existence** with Sentinel-2 & Landsat-8
  - Data acquisition **on demand**





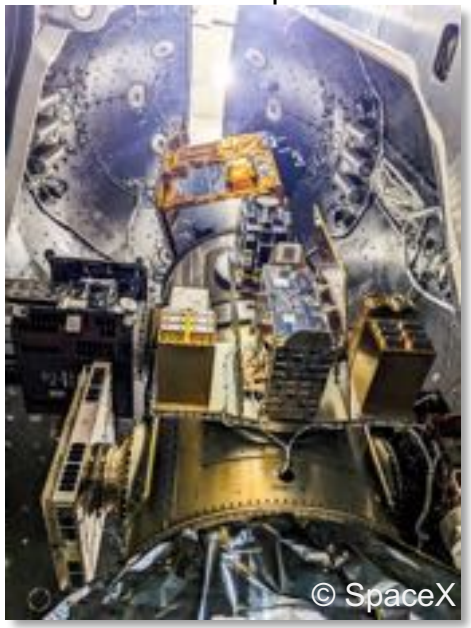
Orbit characteristics		
Orbit / Inclination	sun-synchronous / 97.96°	
Target revisit time	27 days (VZA ± 5°) / 4 days (VZA ± 30°)	
Equator crossing time	11:00 h ± 18 min (local time)	
Instrument characteristics	**VNIR**	**SWIR**
Spectral range	420 – 1000 nm	900 – 2450 nm
Number of bands	88	154
Spectral 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 = 2.65° across track)	
Acquisition length	1000 km/orbit - 5000 km/day	

Mission consortium

- DLR Space Agency in Bonn is responsible for the overall project management
- Core funding from the German Federal Ministry of Economic Affairs and Climate Actions (BMWK)
- GFZ science PI: Extensive Scientific Exploitation preparation program

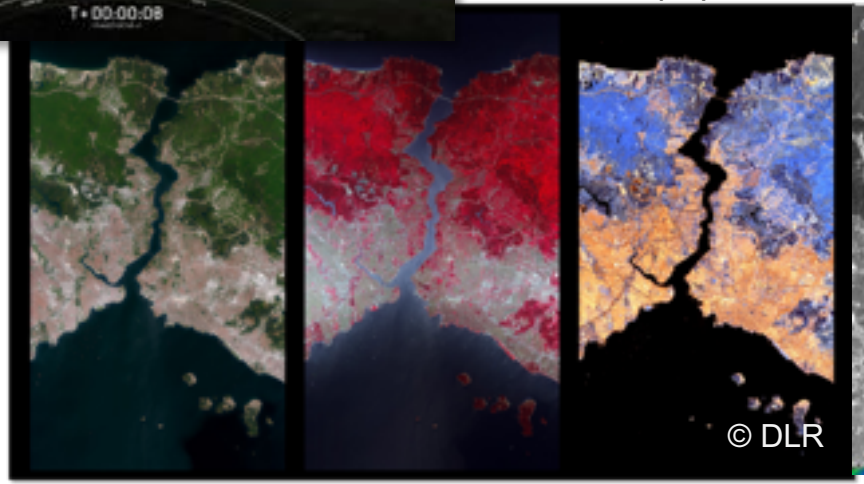
What a year for EnMAP

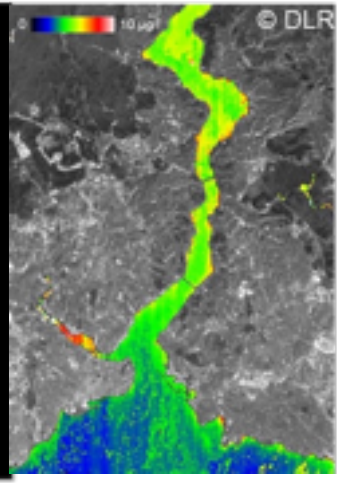
Launch 1. April



Commissioning phase
1st image acquired on 27. April:
Larger area of Istanbul

1st exemplary derivated product:
Chlorophyll content in Bosporus





Commissioning phase tasks

- Verification of sensor performance and calibration ✓
  - On-board calibration sources
  - On ground vicarious validation sites
- Adjustment of Mission planning system for maximized mission efficiency ✓
- Validation of data products (L1B, L1C, L2A) ✓
  - On ground validation sites, in situ measurement campaigns
  - Lead by GFZ
  - Cross validation campaigns with other hyperspectral sensors (DESIS, PRISMA, EMIT, etc..)
- CP review on-going (07-28.10). If green light → **Operational phase opening on 1. Nov**

EnMAP status

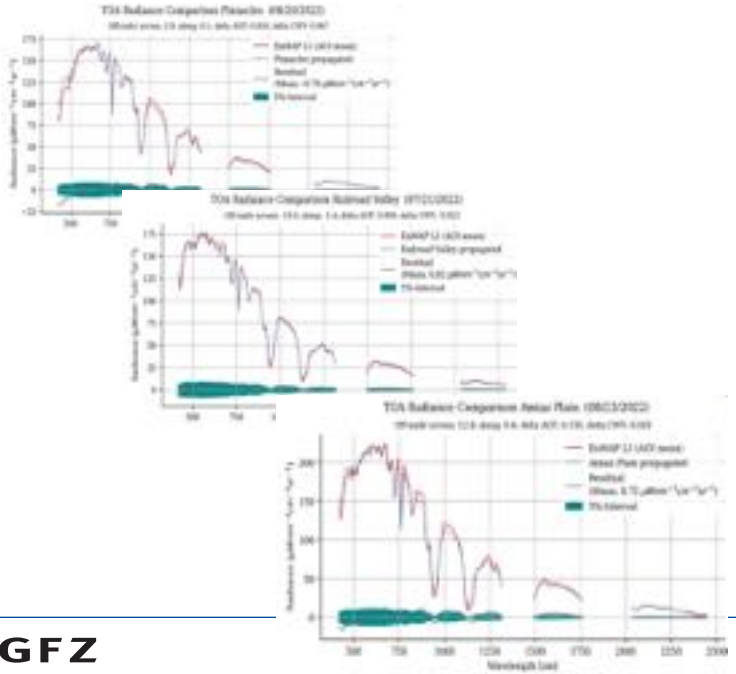
- Calibration and data acquisitions
  - 53 Calibrations
  - >11000 Earth Observation tiles of approx. 30 km x 30 km each
  - 4 Processor deliveries

- External product validation
  - ~20 high priority PI sites + PICS/RadCalNet sites
  - Close-bys with PRISMA, EMIT, DESIS
  - EnMAP validation teams (PI sites)
    - Currently ~15 match-ups in-situ/EnMAP
    - EnMAP in-situ protocol

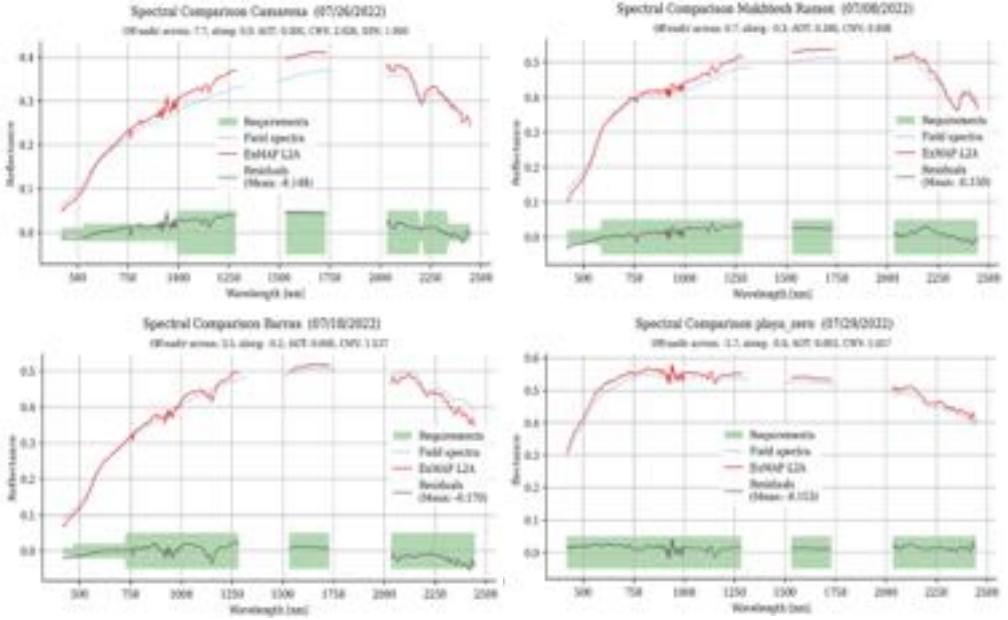
External product validation: Some preliminary results

- A Big **thank you** to all validation in-situ teams that beared with us the whole summer!

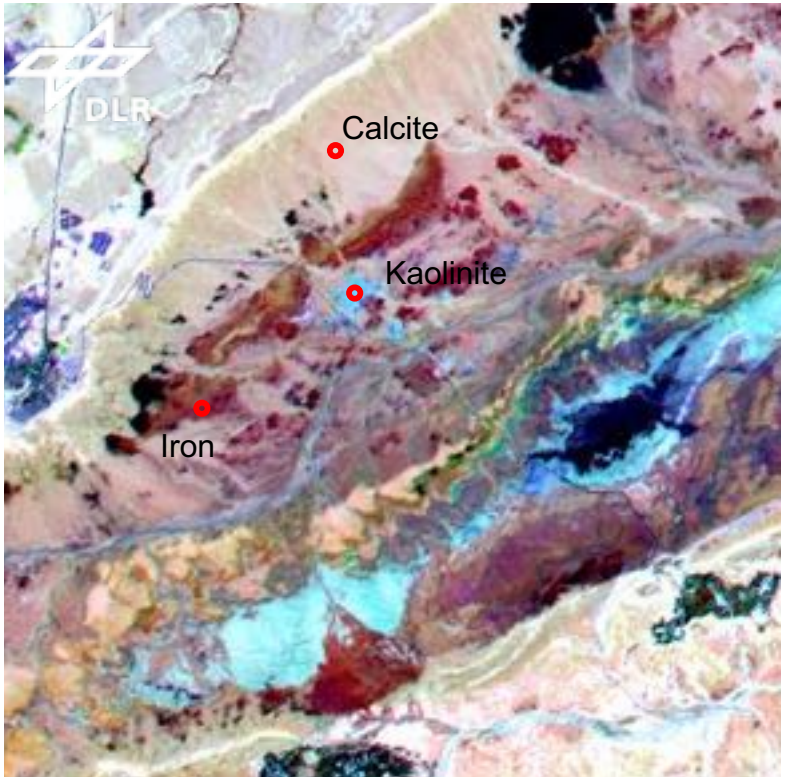
L1B

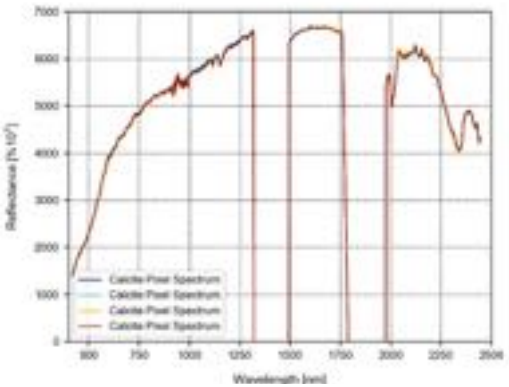


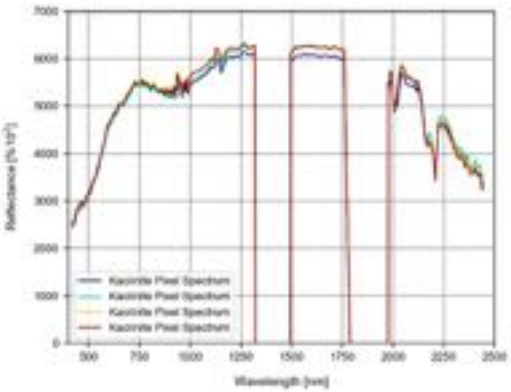
L2A

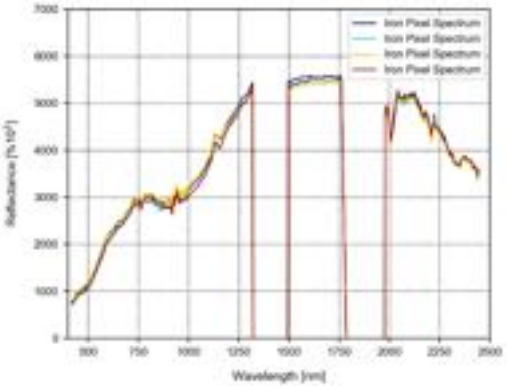


EnMAP scene Maktesh Ramon: 08.07.2022

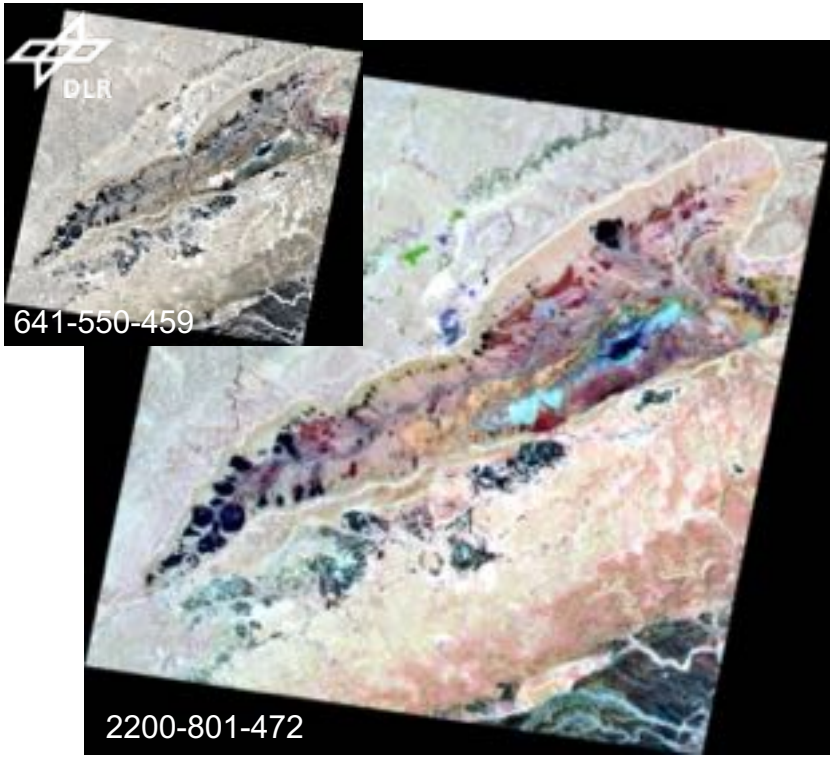




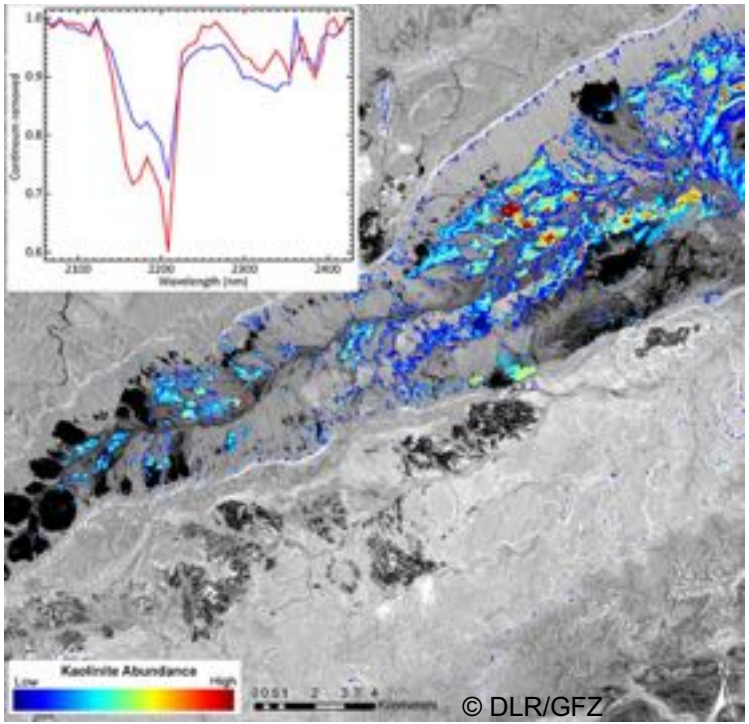




EnMAP scene Maktesh Ramon: 08.07.2022



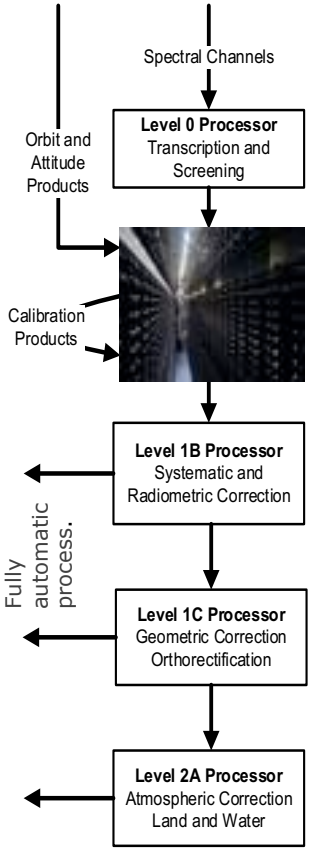
Examplary derivative EnMAP geological product



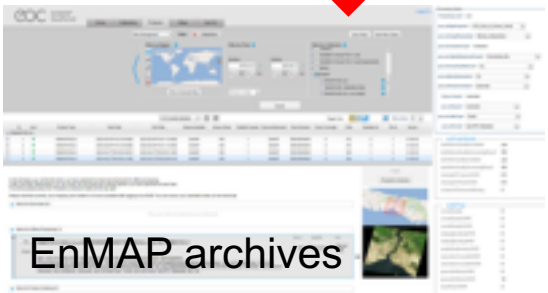
© DLR/GFZ
L2B/L3 product: S. Asadzadeh

https://www.enmap.org/news/2022-09-22

EnMAP users: Processor & observation



- *Internal User*
  - *Mission*
  - *Charter*
- *Category I*
  - *Based on science AO*
  - *With proposal*
- *Category II*
  - *Based on Space Agency*
  - *Without proposal*
- *Background Mission*



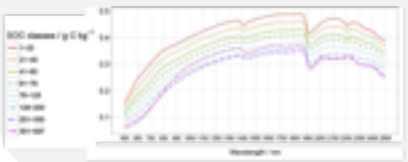
- Scheduling based on:
- Cloud coverage
  - Cloud statistics and forecast
- Satellite restrictions (e.g. maneuvers)
- User priority and quota

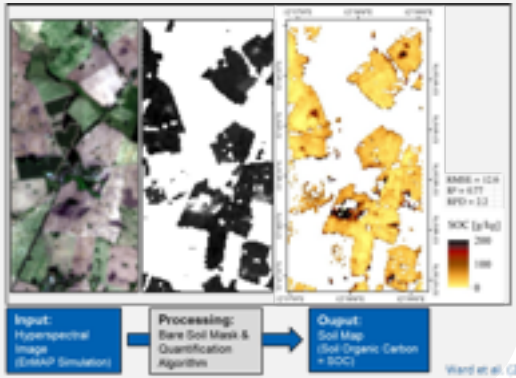
Retrieval of bare Earth surface properties

- Science and methodological developments for several applications; Research focus on
  - Demonstration of IS potential for new EO products
  - Development of practical tools for the user community implemented in QGIS/ EnMAP-Box (EnSoMap, EnGeoMap, EnSnowMap)

Topsoil compositional mapping: Soil Organic Carbon maps, soil texture, soil moisture, soil carbonates, iron oxides content

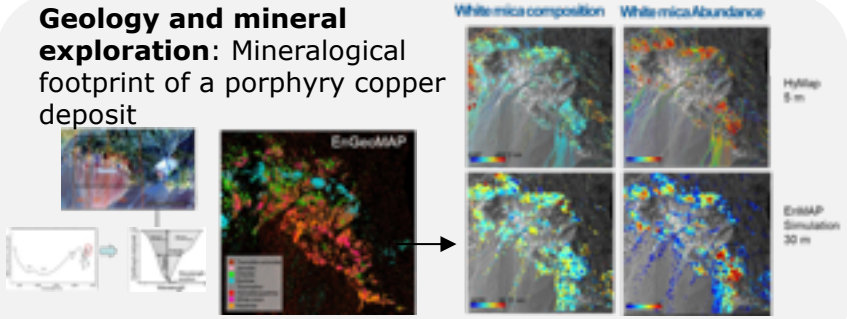
- Food security and climate change
- Visible range important
- Higher SOC → lower albedo
- Multivariate modelling





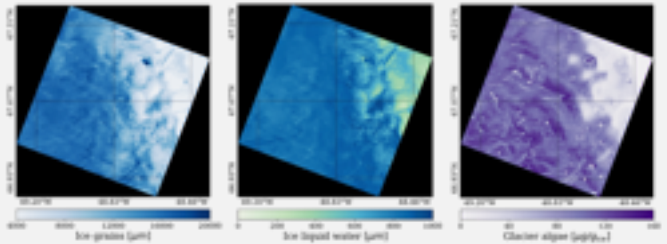
EnMAP simulation

Geology and mineral exploration: Mineralogical footprint of a porphyry copper deposit



Asadzadeh, S., et al. (2022), Targeting exploration drilling using airborne hyperspectral imagery: A case study from the Shadan Porphyry Copper Deposit, Iran, *Economic Geology*, in prep.

Snow & ice properties mapping: Novel combination of retrieval maps and uncertainties for grain size, liquid water, and algae concentration



Bohn, N., et al. (2022). Glacier ice surface properties in South-West Greenland Ice Sheet: First estimates from PRISMA imaging spectroscopy data. *J.G.R.: Biogeosc.*, 127

Outlook

- EnMAP 1st german hyperspectral mission: Data to be open soon to the public
- Extensive scientific exploitation program since > decade
  - **Mission science support** (EnMAP-Box, hyperEDU, and more..)
  - **EnMAP Legacy** → Involvment in next missions in preparation and related activities
    - Contributions to next missions in preparation (CHIME, SBG)
    - IEEE-Standards Association P4005
    - Projects e.g. CHIME E2E processor, Worldsoil EU soil maps
    - Common calval, supersites, reference data, feature modeling,..

- EnMAP & upcoming spaceborne IS missions: Synergies with other sensors and contribution to Copernicus services
  - **Scientific exploitation in various GEO-fields** and key Green Deal challenges (climate neutrality [soil/vegetation carbon], disturbances/land degradation, sustainable development goals, food security, sustainable metal sourcing)
  - **Combined data exploitation with current missions**: Global and rapid land monitoring and tracking critical Earth System processes (DESIS, PRISMA, HISUI, Geofen-5, EnMAP, EMIT, ..)
  - **Developing future Copernicus GEO-services** (e.g. upcoming Copernicus hyperspectral mission)

Thank you for your attention!