

Imaging spectroscopy data in QGIS: Challenges and Opportunities

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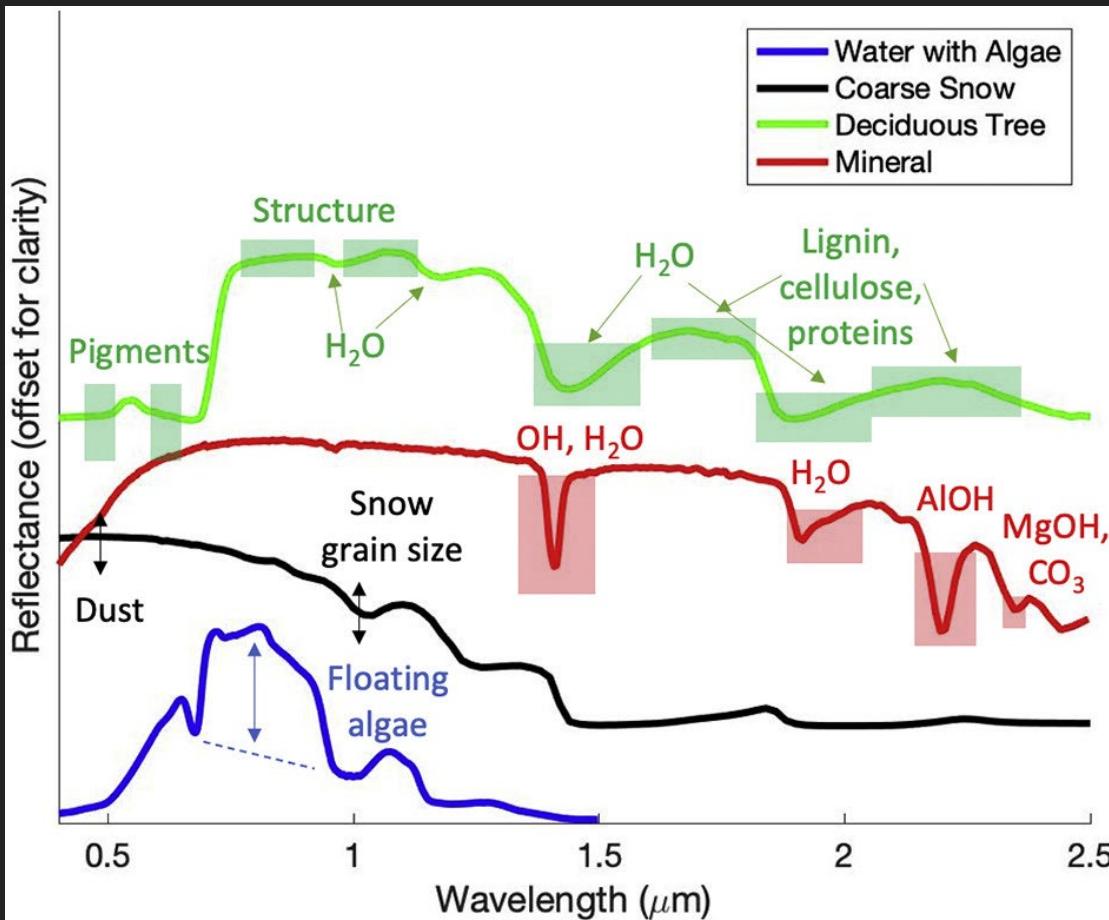
Spectrometry

Laboratory- & Fieldspectrometer

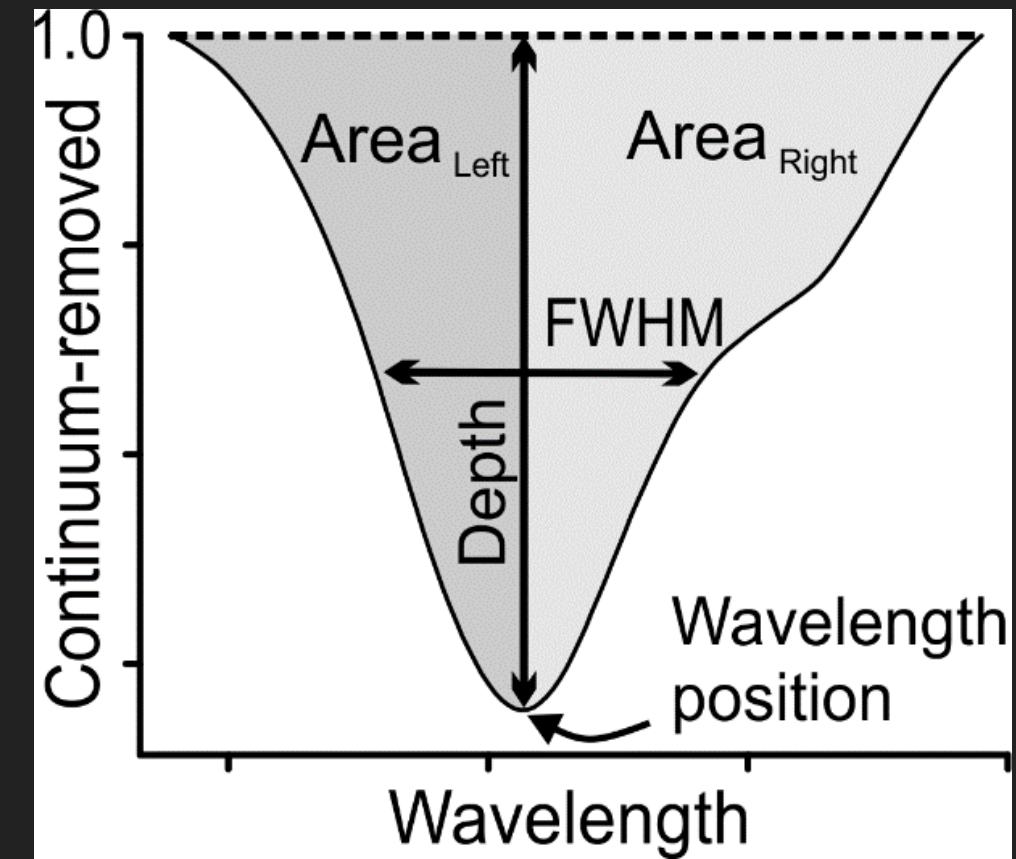


Spectroscopy

- Spectral Profiles are *fingerprints* of materials & surfaces



Cawse-Nicholson et al. 2021 (modified)



Saeid Asadzade 2023



Spectroscopy

EnMAP-Box: IVVRM tool (Danner 2018)

Interactive Visualization of Vegetation Reflectance Models

Sensor Type

Select sensor

400-2500 nm @ 1nm

bands:

Select Leaf Model

- Prospect 3
- Prospect 5b
- Prospect 4
- Prospect D
- Prospect 5
- Prospect Pro

Select Canopy Model

- Leaf Model Only
- 4Sail
- Sail 2M
- Inform

Select Background

- Use default soil spectr
- Load background spectrum
- Find background spectrum

Brightness Factor

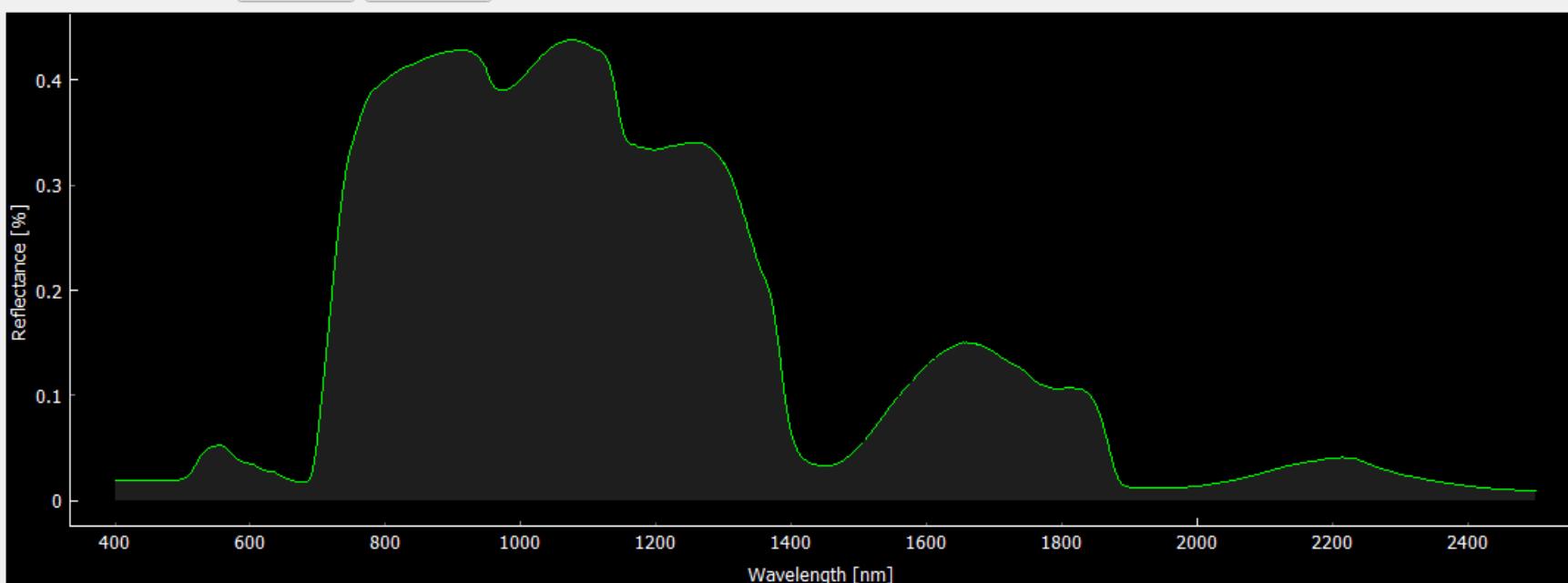
0.8

Select File...

Image...

Show Soil Spectrum

[How to use this tool](#)



Load In Situ Data... Reset In Situ Close App

Save Spectrum...

Save Parameter Set...

Leaf Model Parameters

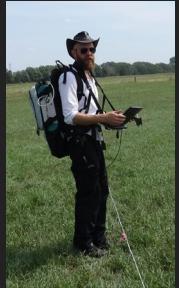
- Structure Parameter (N) 1.5 [-]
- Chlorophyll A + B (Cab) 40 [$\mu\text{g}/\text{cm}^2$]
- Water Content (Cw) 0.03 [cm]
- Dry Matter (Cm) 0.012 [g/cm^2]
- Carotenoids (Ccox) 10 [$\mu\text{g}/\text{cm}^2$]
- Brown Pigments (Cbrown) 0.25 [-]
- Anthocyanins (Canth) 2 [$\mu\text{g}/\text{cm}^2$]
- Proteins (Cp) 0.0015 [g/cm^2]
- Carbon-based constit. (CBC) 0.01 [g/cm^2]

Canopy Model Parameters

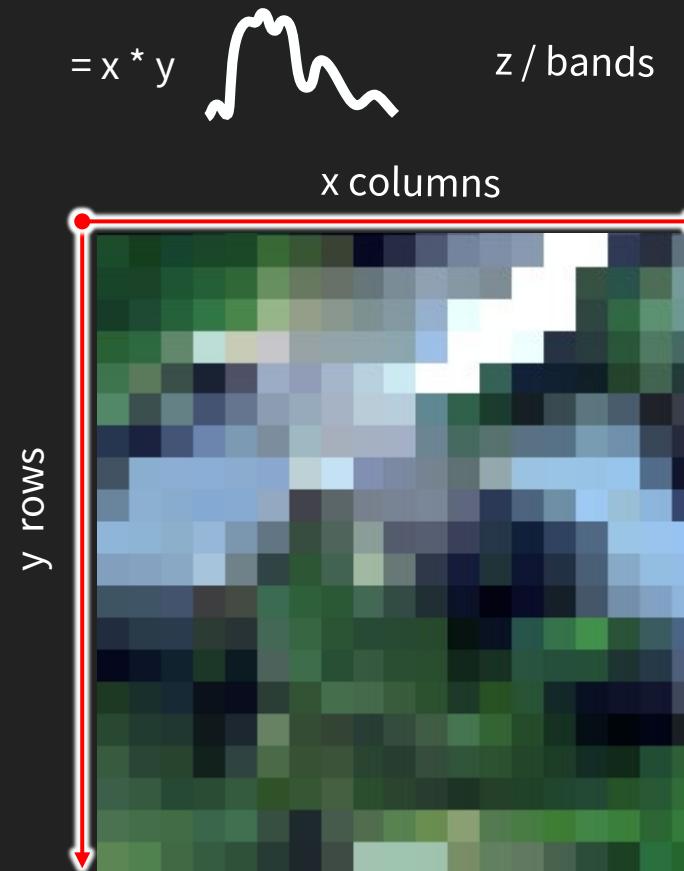
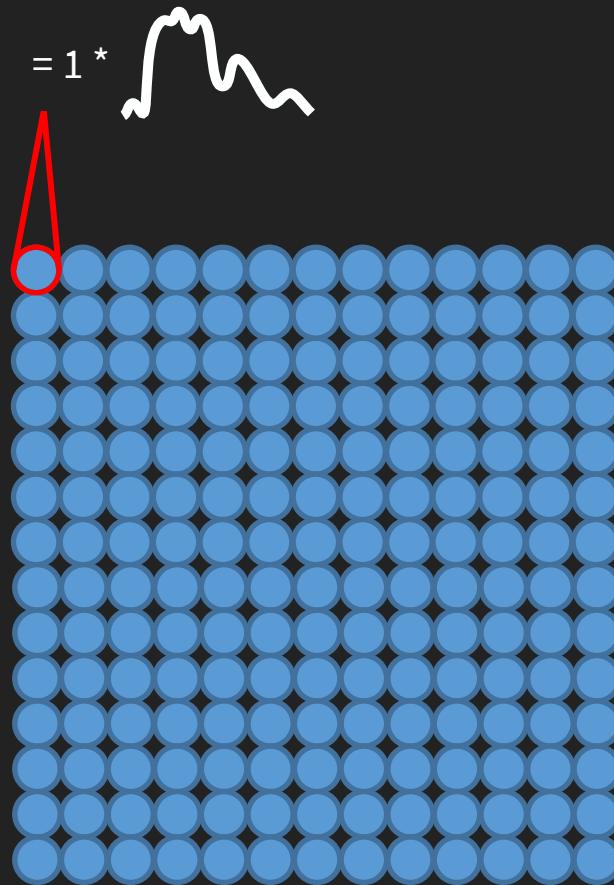
- Leaf Area Index (LAI) 3 [m^2/m^2]
- Ellipsoidal
- Leaf Angle 30 [deg]



Imaging Spectroscopy

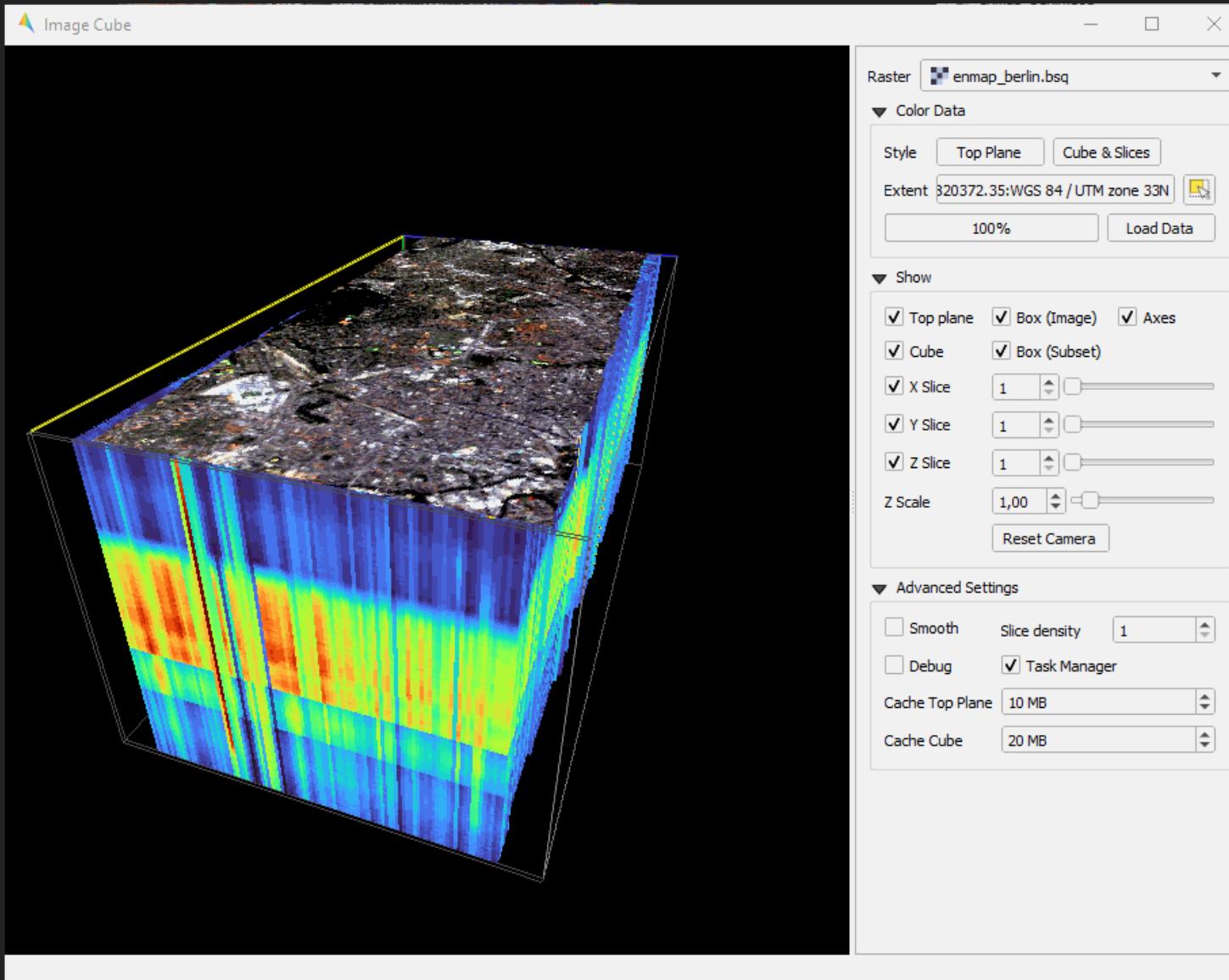


Move



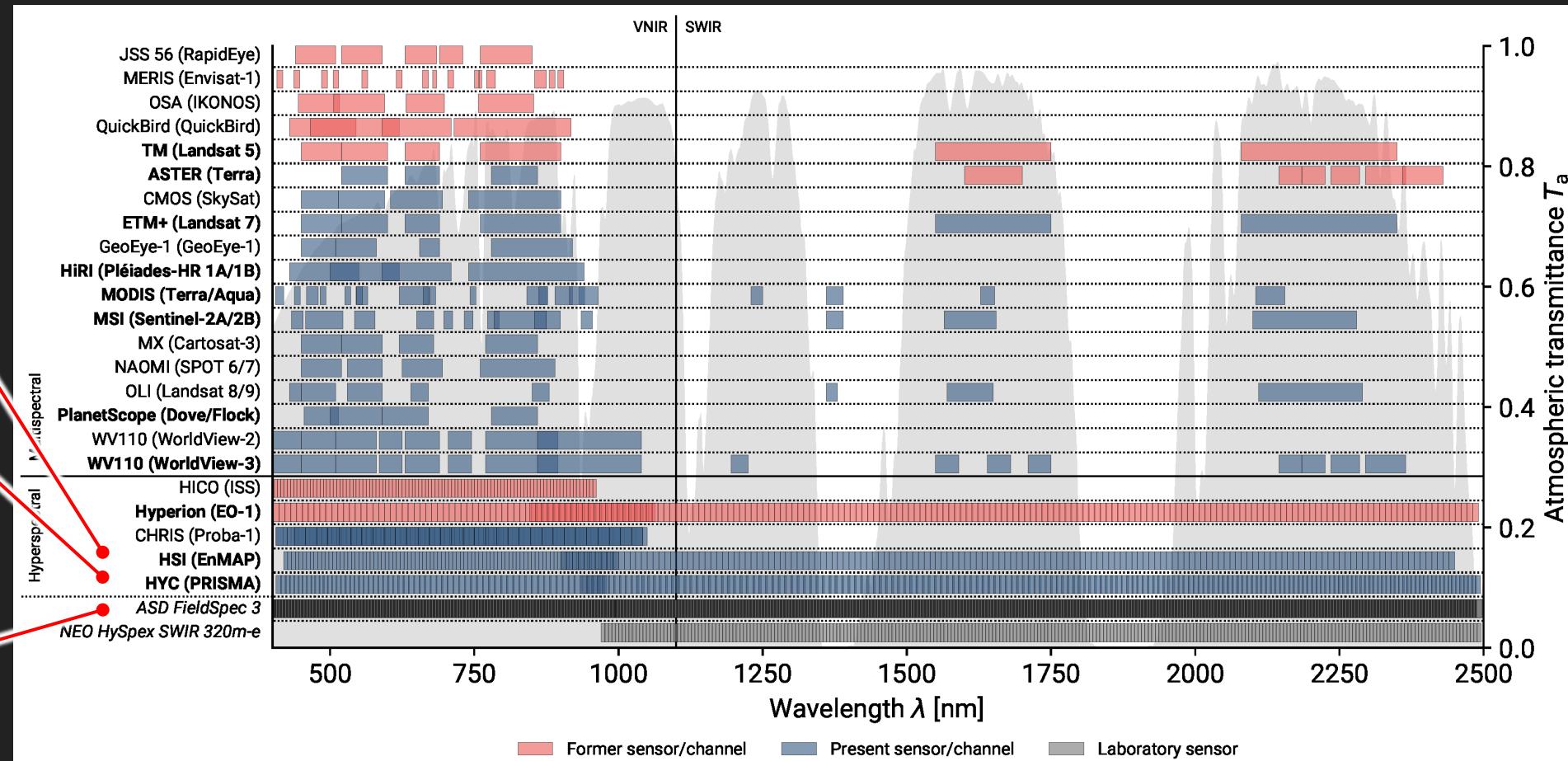


Imaging Spectroscopy



EnMAP-Box: Image Cube tool

Imaging Spectroscopy Missions

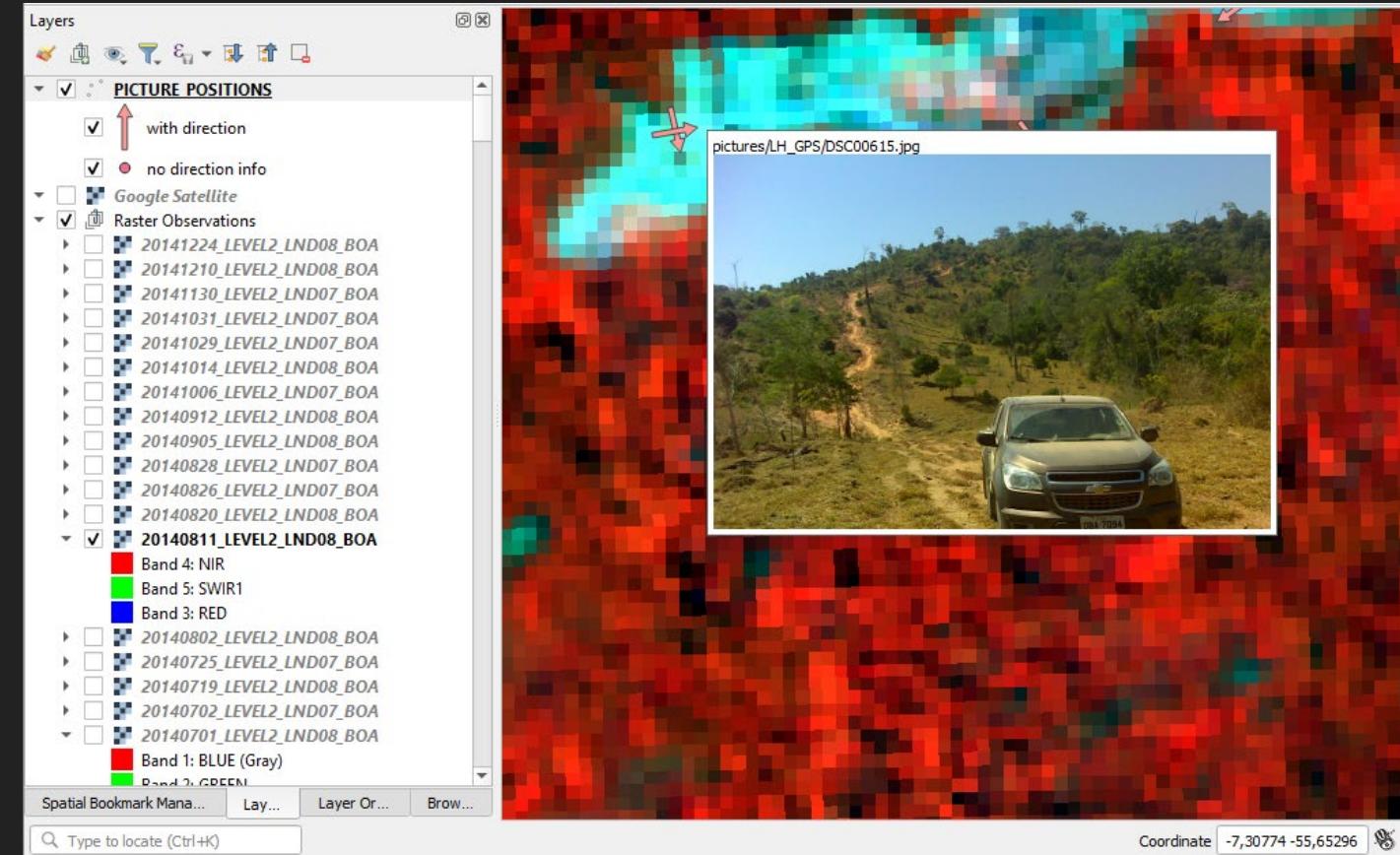
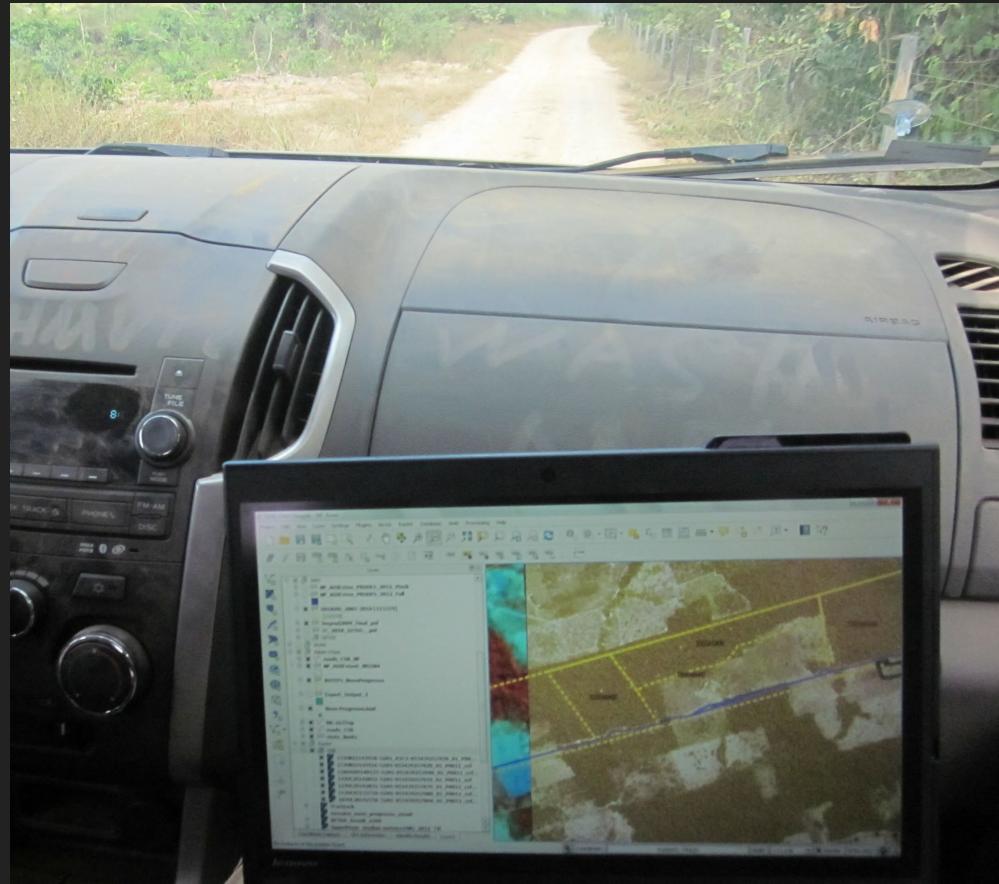


Schmidt et al. 2023 „Potential of Optical Spaceborne Sensors for the Differentiation of Plastics in the Environment“

- Future Missions: CHIME, SBG, ...



Why QGIS for IS / Remote Sensing?





Why QGIS for IS / Remote Sensing?

- Free & Open source

- Easy to use & integrate

- Powerful Ecosystem

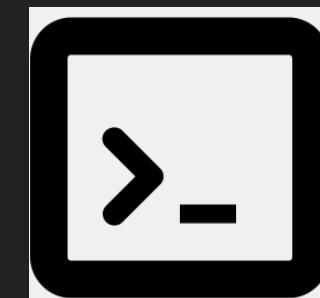
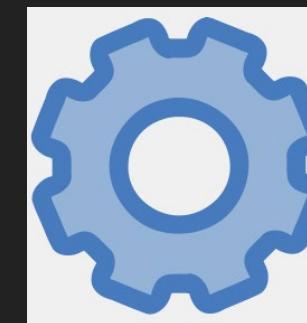
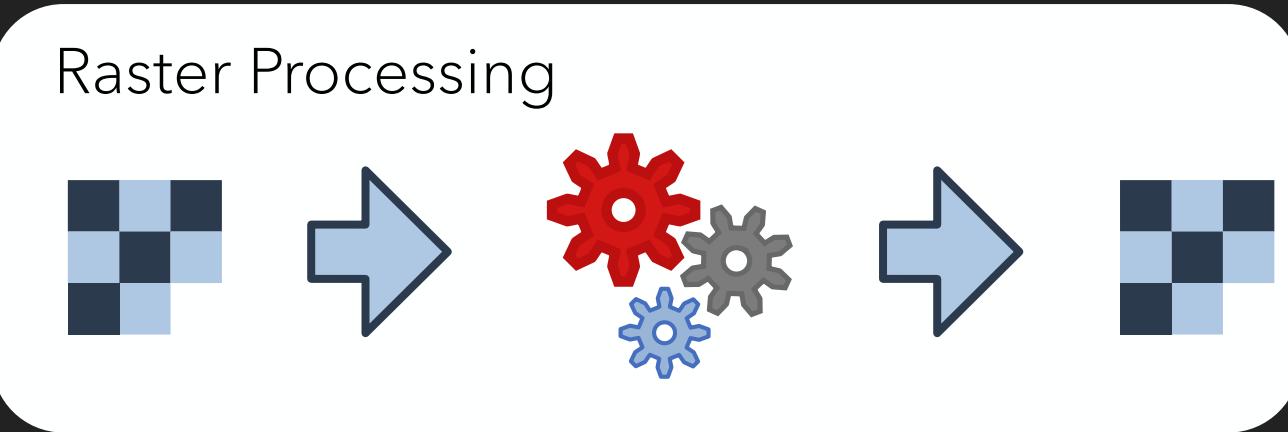
Semi-Automatic Classification Plugin

PCRaster Tools Plugin

GRASS GIS

SAGA

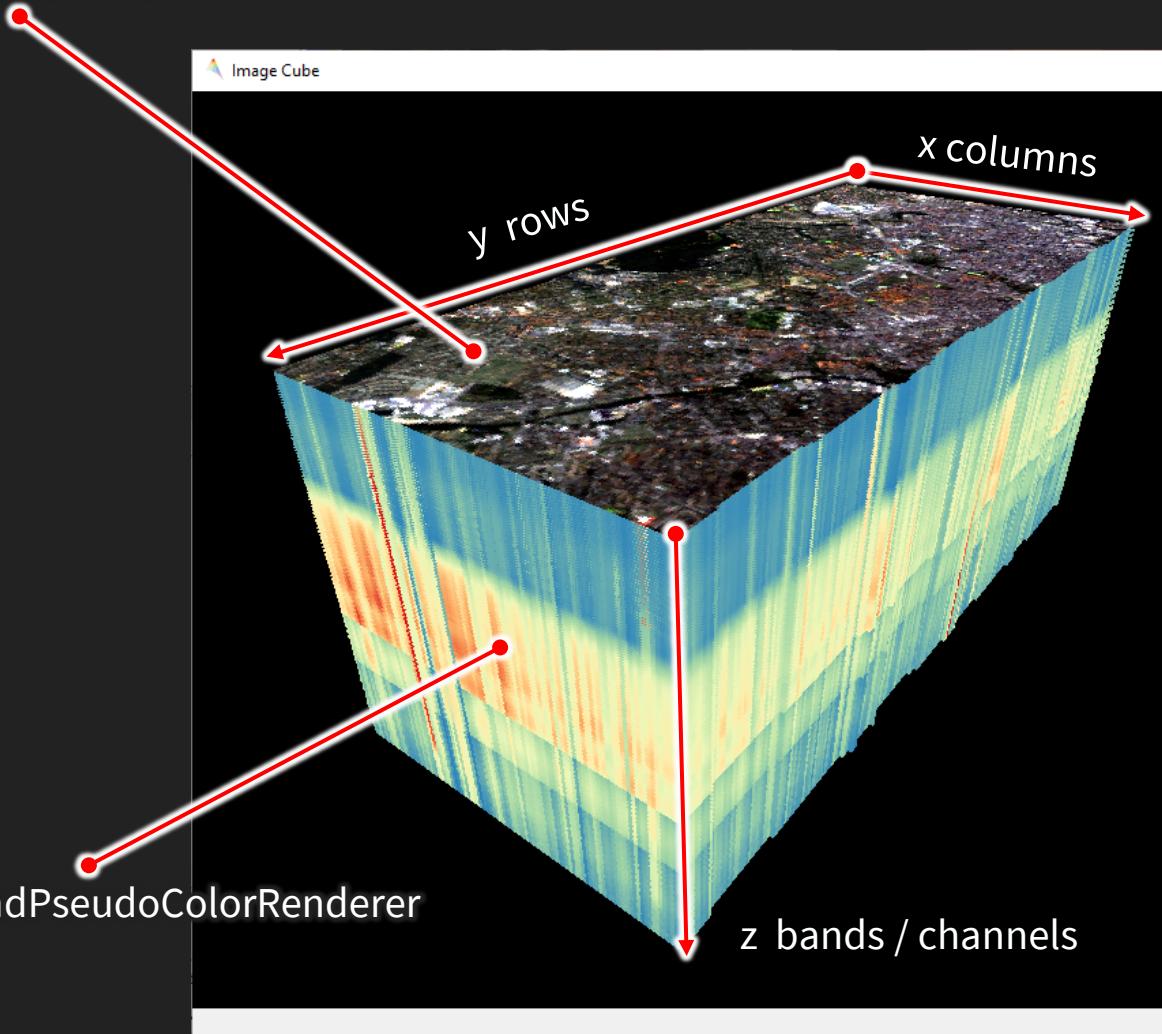
- Powerful API



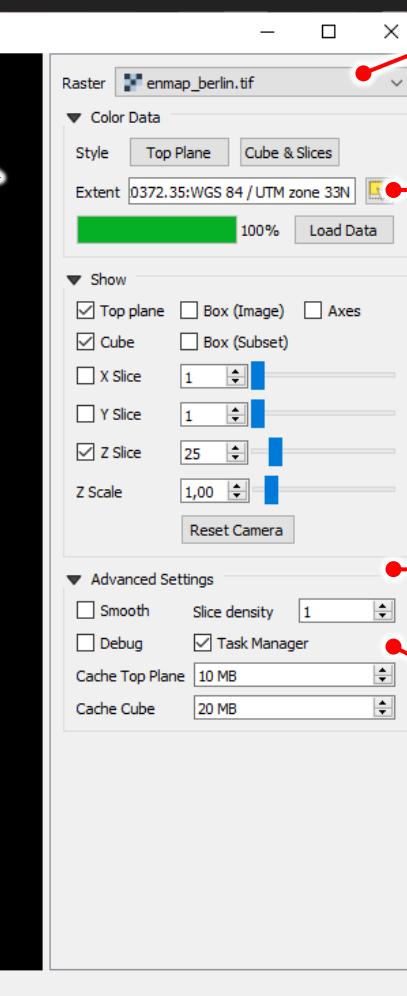


Realized with help of PyQGIS

QgsMultiBandColorRenderer



QgsSingleBandPseudoColorRenderer



QgsMapLayerComboBox

QgsExtentWidget

QgsCollapsibleGroupBox

QgsTaskManager

Get Imaging Spectroscopy Data

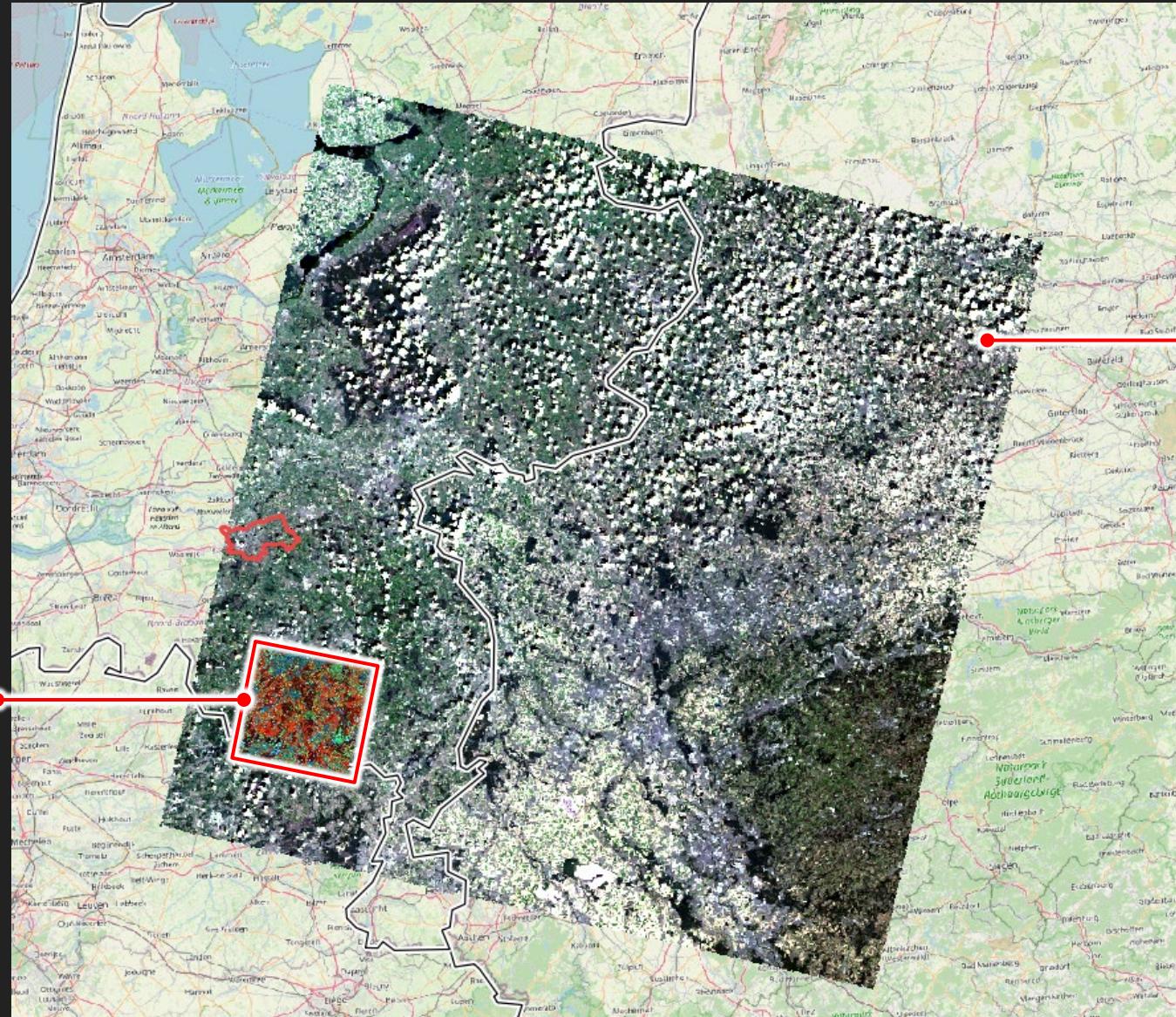
- Mission data portals
- Archives with aerial data
 - Airborne Flight Campaigns
 - AVIRIS, HyMAP, ...

More data in future

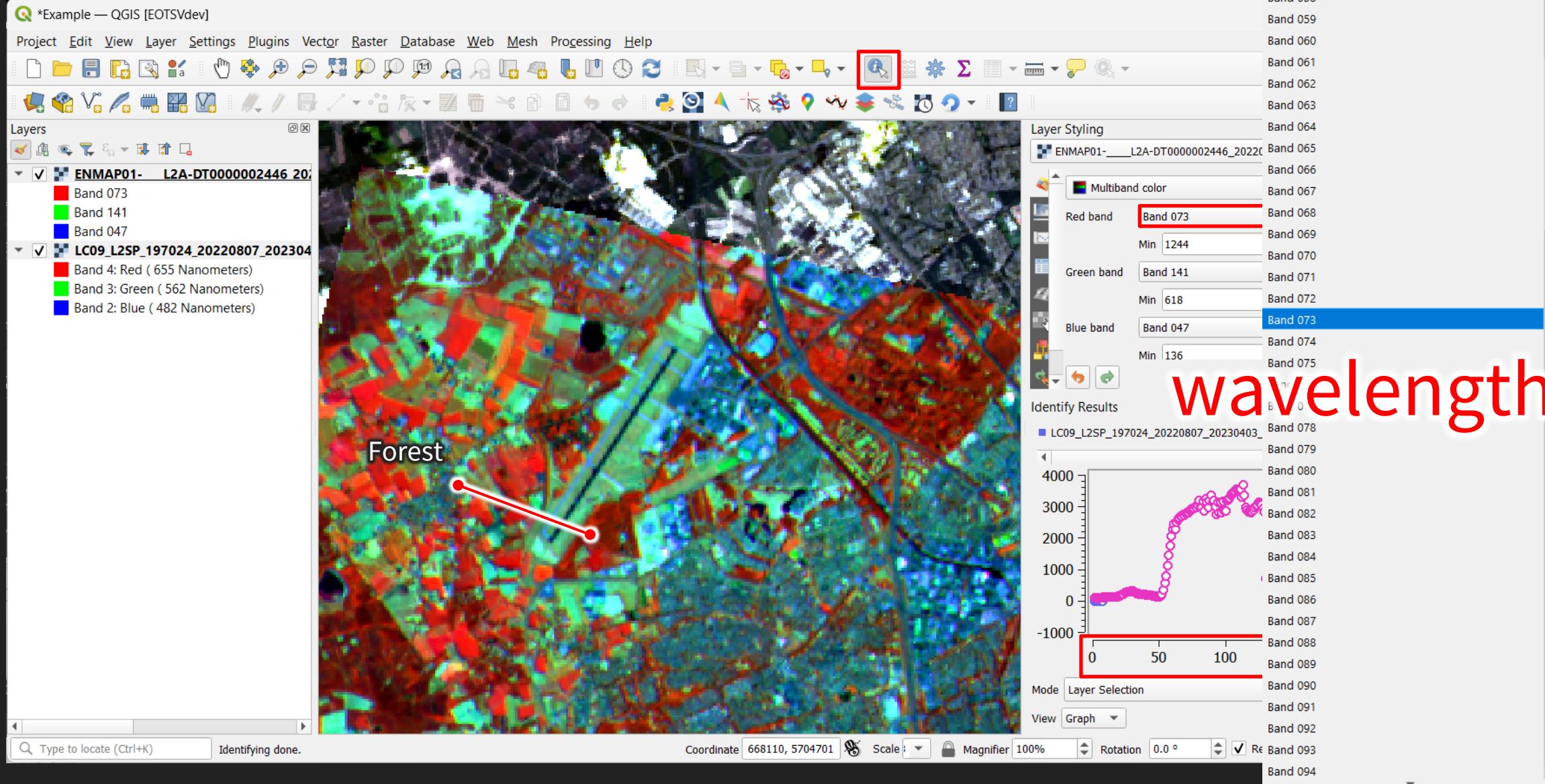
The screenshot shows the EOWEB GeoPortal interface. At the top, there are tabs for Home, Collections, Products (which is selected), Maps, and Cart (0). The URL is https://eoweb.dlr.de/egp/main#mainWindowtabExplore. A blue bracket on the left points to the 'Filter Management' dropdown and the 'Filter by Region' section. The 'Filter by Region' section includes a map of Hertogenbosch with a yellow bounding box, zoom controls, and a 'Show Advanced Map' button. The 'Filter by Time' section has 'Starttime' set to 1970-01-01 00:00:00 and 'Endtime' set to 2023-04-06 23:59:59. The 'Filter by Collection' section lists several missions: TanDEM-X Pursuit TSX-1 Like, TanDEM-X Pursuit TSX-1 Like Experimental, DESIS, EnMAP, and EnMAP-HSI. Under DESIS, DESIS.HSI.L1A is selected, showing two results: one from 2019-02-12T13:24:41.173Z to 2019-02-12T13:24:45.520Z and another from 2018-10-09T15:01:21.833Z to 2018-10-09T15:01:26.178Z. The 'Product Type' column indicates DESIS.HSI.L1A for both. The 'Mission/Satellite' column shows ISS for both. Below the table, a map shows a red polygon over a terrain image, and a preview image of the satellite data is shown.

Nr	Avail.	Product Type	Start Date	End Date	Mission/Satellite
1	●	DESiS.HSI.L1A	2019-02-12T13:24:41.173Z	2019-02-12T13:24:45.520Z	ISS
2	●	DESiS.HSI.L1A	2018-10-09T15:01:21.833Z	2018-10-09T15:01:26.178Z	ISS

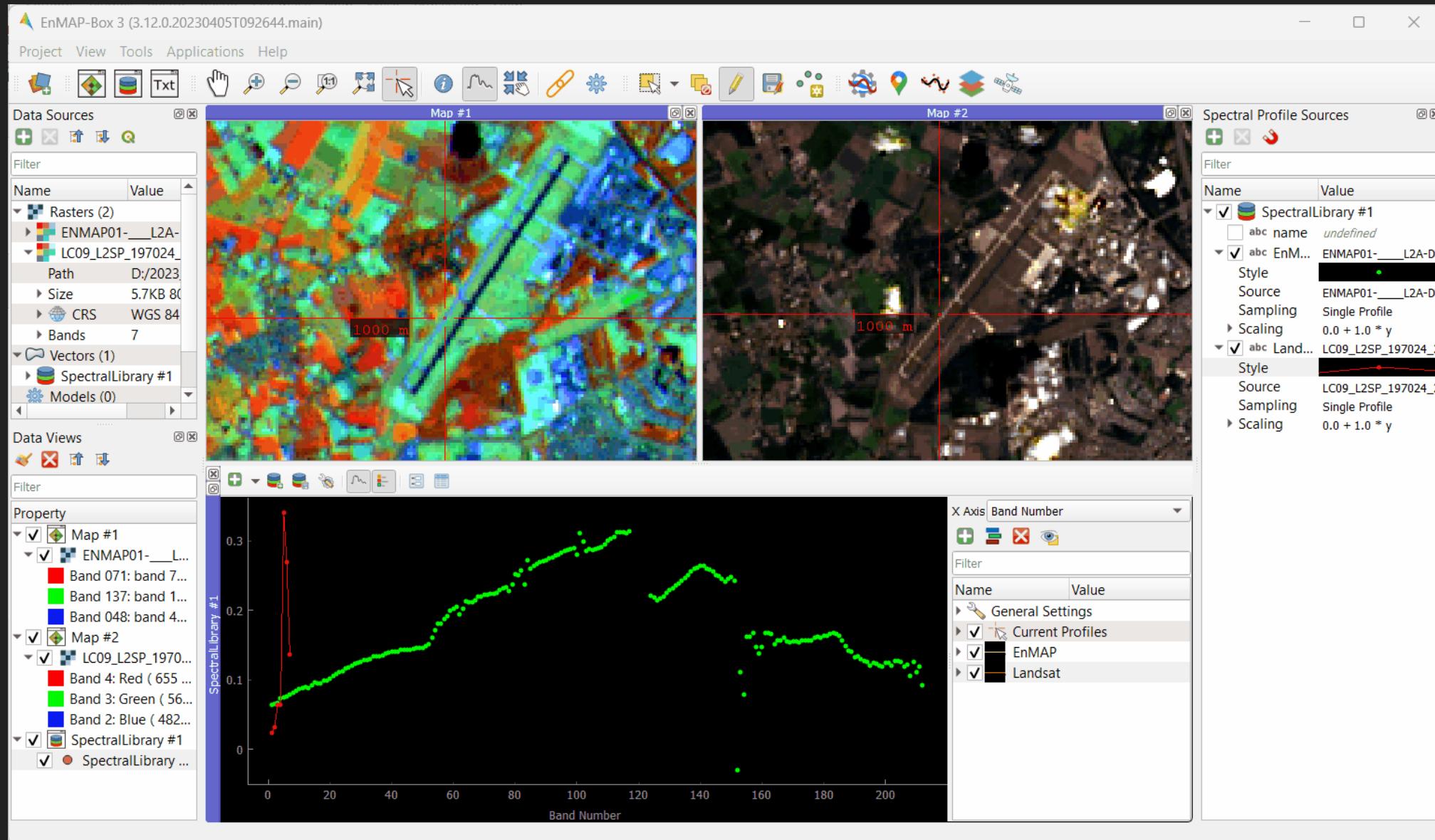
Challenges



Challenges



Pixel Profiles vs. Spectral Profiles





EO-specific metadata in QGIS?

- GDAL metadata

The screenshot shows the 'Layer Properties' dialog for a layer named 'ENMAP01-__L2A-DT000005053_20221105T104130Z_008_V010111_20230213T084607Z'. The left sidebar has 'Information' selected. The main panel is titled 'Bands' and displays a table of band properties. The table has columns: Number, Band, No-Data, Min, and Max. There are 224 bands. The first few bands are listed:

Number	Band	No-Data	Min	Max
1	Band 001: band 1 (418.24 Nanometers)	-32768	-0.0014000000	1.5948000000
2	Band 002: band 2 (423.874 Nanometers)	-32768	-0.0077000000	1.5759000000
3	Band 003: band 3 (429.294 Nanometers)	-32768	-0.0082000000	1.5469000000
4	Band 004: band 4 (434.528 Nanometers)	-32768	-0.0017000000	1.5112000000
5	Band 005: band 5 (439.603 Nanometers)	-32768	-0.0022000000	1.5044000000
6	Band 006: band 6 (444.549 Nanometers)	-32768	-0.0006000000	1.4733000000
7	Band 007: band 7 (449.391 Nanometers)	-32768	0.0011000000	1.4464000000
8	Band 008: band 8 (454.159 Nanometers)	-32768	0.0010000000	1.4328000000
9	Band 009: band 9 (458.884 Nanometers)	-32768	-0.0010000000	1.4041000000

Buttons at the bottom right include OK, Cancel, Apply, and Help.

- QGIS issue #19127

A dark-themed modal window for issue #19127. The title is 'wavelength support for hyperspectral images' with 'Feature Request' and 'Raster' tags. It says '#19127 opened on 27 Jun 2014 by qgib' and 'Future Release - ...'.



Spatio Temporal Asset Catalogs (STAC)



- “a common language to describe geospatial information”
- extensible
- <https://stacspec.org>
- <https://stac-extensions.github.io/>

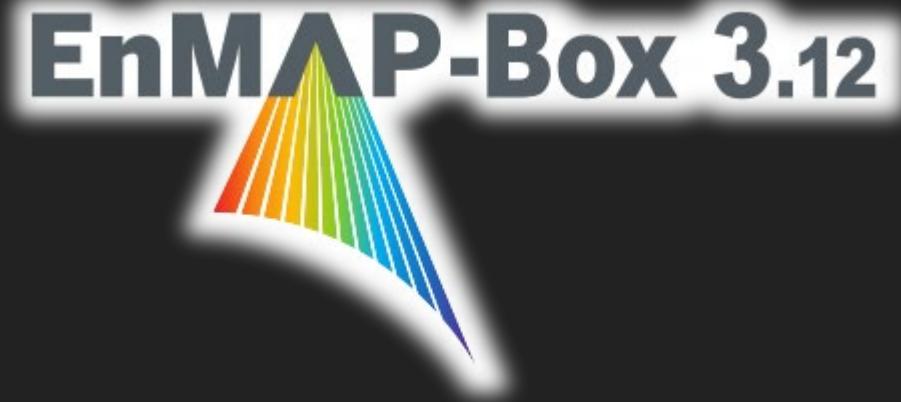
```
81     ],
82     "eo:bands": [
83       {
84         "name": "band1",
85         "common_name": "blue",
86         "center_wavelength": 0.47,
87         "full_width_half_max": 0.07,
88         "solar_illumination": 1959.66
89       },
90       {
91         "name": "band2",
92         "common_name": "green",
93         "center_wavelength": 0.56,
94         "full_width_half_max": 0.08,
95         "solar_illumination": 1823.24
96       },

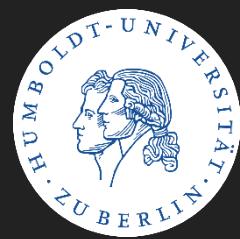
```

CARD4L (Optical and SAR)	card4l	Item	Pilot	0.1.0	Describes how to comply to the CEOS CARD4L specifications (SAR and Optical) with STAC
CF*	cf	Collection, Item	WIP	Unreleased	None
Camera*	camera	Collection, Item	WIP	Unknown	Camera related metadata, such as focal length and sequence number. Especially useful for aerial imagery surveys.
Classification	classification	Collection, Item	Pilot	1.1.0	Describes categorical values and bitfields to give values in a file a certain meaning (classification).
Composite	composite	Item	WIP	Unreleased	Defines how virtual assets can be composed from existing assets in STAC
Datacube	cube	Collection, Item	Candidate	2.1.0	Datacube related metadata to describe their dimensions and variables.
Deep Learning Model Extension*	dlm	Collection, Item	WIP	Unreleased	Deep Learning Model STAC Extension
Disasters Charter*	disaster	Collection, Item	Proposal	1.0.0	Disaster Charter Extension Specification
Electro-Optical	eo	Collection, Item	Stable	1.1.0	Covers electro-optical data that represents a snapshot of the Earth. It could consist of cloud cover and multiple spectral bands, for example visible bands, infrared bands, red edge bands and panchromatic bands.

Interested in Imaging Spectroscopy?

- Next presentation: Andreas Janz „EnMAP-Box“
- <https://eo-college.org>
- HYPERedu online learning initiative





Thanks for your attention!

<https://www.enmap.org/>
<https://enmap-box.readthedocs.io>



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References

- EnMAP-Box <https://enmap-box.readthedocs.io>
- EO College e-learning materials: <https://eo-college.org>
- A. Brosinsky, T. Kuester, S. Foerster, H. Kaufmann, K. Segl, L. Guanter (2019). Principles of imaging spectroscopy - Electromagnetic radiation and its interactions with earth surface materials, slide collection, HYPERedu, EnMAP education initiative, August 2019, German Centre for Geosciences GFZ.
- M. Danner, M. Wocher, K. Berger, W. Mauser and T. Hank, "Developing a Sandbox Environment for Prosail, Suitable for Education and Research," IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium, 2018, pp. 783-786, doi: 10.1109/IGARSS.2018.8519378.
- Schmidt, T.; Kuester, T.; Smith, T.; Bochow, M. Potential of Optical Spaceborne Sensors for the Differentiation of Plastics in the Environment. *Remote Sens.* 2023, 15, 2020. <https://doi.org/10.3390/rs15082020>
- Cawse-Nicholson, Kerry, Philip A. Townsend, David Schimel, Ali M. Assiri, Pamela L. Blake, Maria Fabrizia Buongiorno, Petya Campbell, et al. 'NASA's Surface Biology and Geology Designated Observable: A Perspective on Surface Imaging Algorithms'. *Remote Sensing of Environment* 257 (May 2021): 112349. <https://doi.org/10.1016/j.rse.2021.112349>.