

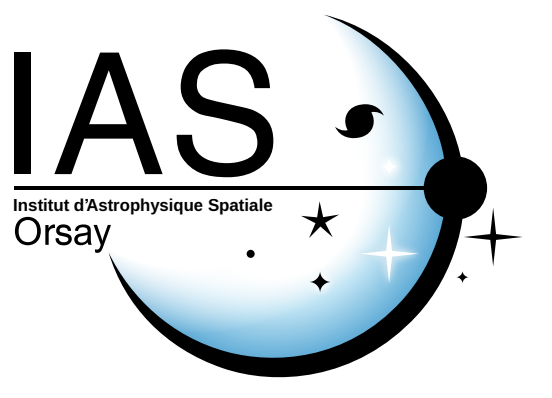


The OMEGA-Py Python module: a complete and easy way to work with OMEGA/MEX observations



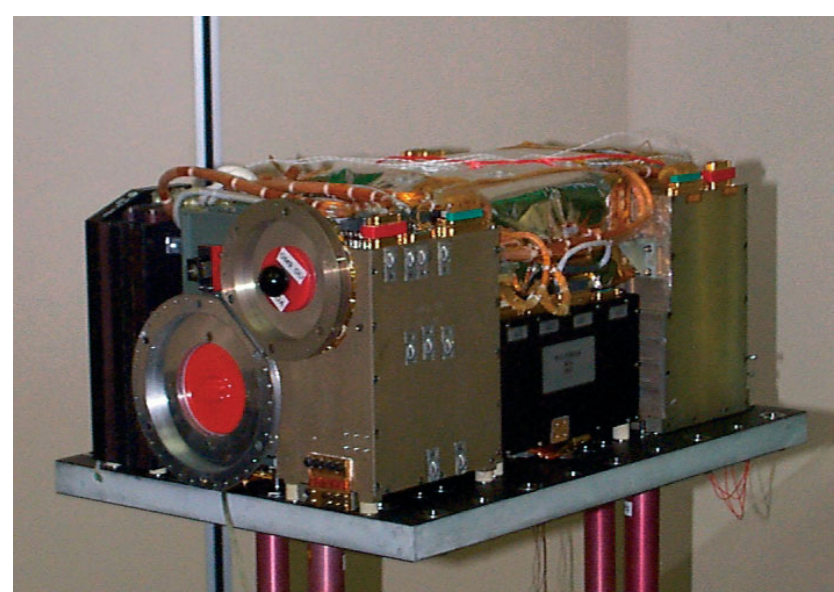
Aurélien Stcherbinine¹,
J. Carter^{2,3}, Y. Langevin², M. Vincendon², Y. Leseigneur⁴, O. Barraud⁵, F. Schmidt^{6,7}

¹ IRAP, CNES, Université Toulouse III Paul Sabatier, CNRS, Toulouse, France
² IAS, Université Paris-Saclay, CNRS, Orsay, France
³ LAM, University Aix-Marseille, CNRS, CNES, Marseille, France
⁴ LATMOS/IPSL, UVSQ Université Paris-Saclay, CNRS, Sorbonne Université, Guyancourt, France
⁵ German Aerospace Center (DLR), Institute of Space Research, Berlin, Germany
⁶ Université Paris-Saclay, CNRS, GEOPS, Orsay, France
⁷ Institut Universitaire de France, IUF, Paris, France

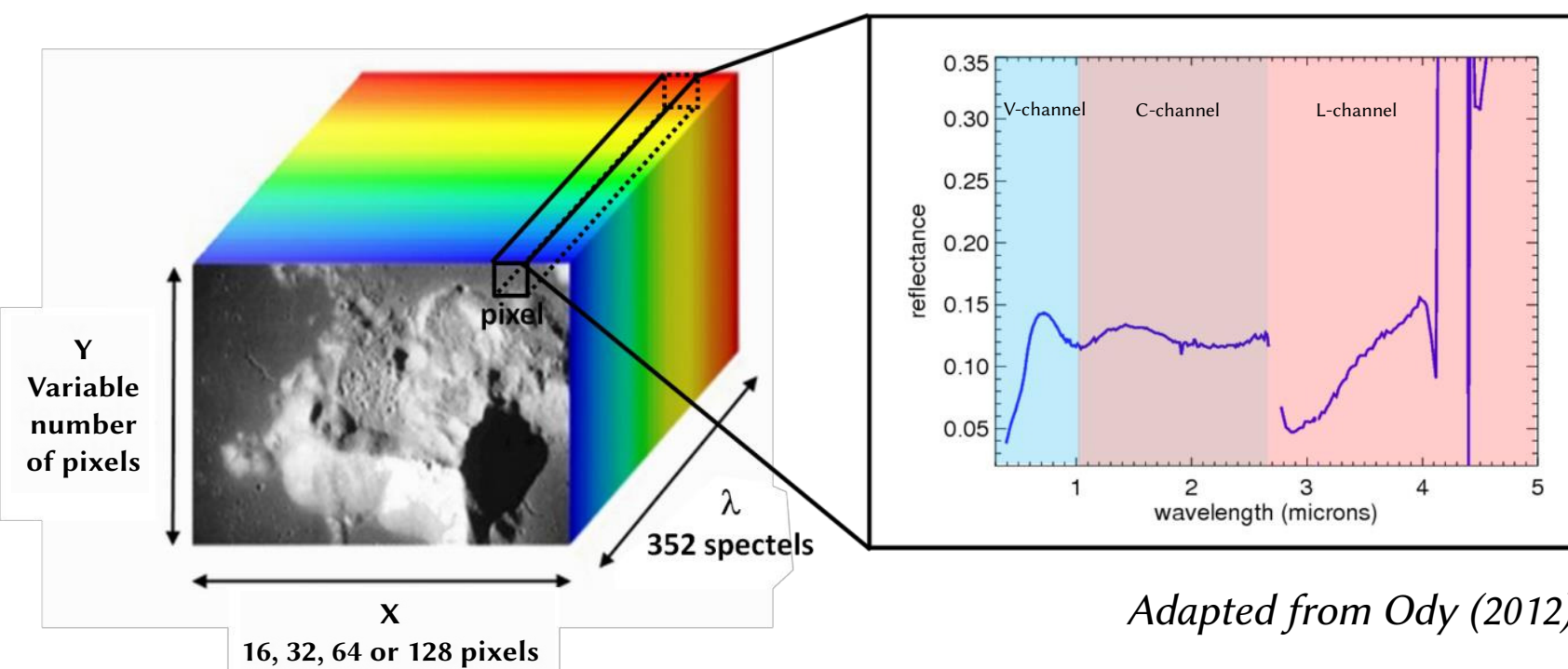


THE OMEGA INSTRUMENT

- Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité
- Vis-IR imaging spectrometer onboard ESA Mars Express orbiter
- Operating since 2004 (currently extended until 2026)
- Complete and unique dataset rich of 20 years of observations!
- Covers the 0.35 – 5.1 μm spectral range over 352 spectels
- 3 channels: V / C / L (no C-channel since 2010)
- Spatial resolution = 300 m to 2-5 km



OMEGA Flight Model (Bibring et al., 2004)



DATA IMPORTATION, HANDLING & CORRECTION

Data importation

```
2: omega = OMEGAdata('0967')
1: /data2/opt/geoneg/data/product/ORB0967_0.QUB
2: /data2/opt/geoneg/data/product/ORB0967_1.QUB
3: /data2/opt/geoneg/data/product/ORB0967_2.QUB
4: /data2/opt/geoneg/data/product/ORB0967_3.QUB
5: /data2/opt/geoneg/data/product/ORB0967_4.QUB
6: /data2/opt/geoneg/data/product/ORB0967_5.QUB
7: /data2/opt/geoneg/data/product/ORB0967_6.QUB
Enter the corresponding number to select one filename :
>>> 4
Computing OMEGA observation ORB0967_3
core: 128 352 596 cbyte: 2
suffix: 1 7 0 bbyte: 4
0 or less IR: 173673
negative pixels VIS: 12402
anomalous pixels VIS: 100
saturated pixels VIS: 100
spikes VIS: 3385
Computing data extraction and correction... [done]
```

- Read L1B binaries to produce L2A data, similarly to the *SOFT 10* readomega.pro IDL routine.

- Clever search for observations.
- Spectral correction: re-ordering wavelengths + removing overlaps.
- "No-verbose" importation option.
- Possibility to skip V and/or L channels corrections to fasten importation.

New features

Data handling

```
3: omega
0:1:3
OMEGA/MEX observation ORB0967_3 - (v2)
Ls = 103.5° - MY 27
Cube quality : 3
Thermal correction : False
Atmospheric correction : False
Corrupted 128 pixels cube
```

- Object Oriented Programming
- Easy handling of multiple OMEGA observations
- Saving/Loading of OMEGAdata objects

- All informations are stored as attributes of the OMEGAdata class:

- omega.name: observation ID
- omega.lam: wavelength array
- omega.cube_rf: I/F.cos(i) data cube [X, Y, λ]
- omega.ls: Solar Longitude (L_s)
- omega.lat: Latitude array [X, Y]
- omega.lon: Longitude array [X, Y]
- etc

- Getters for the whole headers if needed.

Thermal correction

- Required to use the L-channel ($\lambda > 2.7 \mu\text{m}$)
- 2 methods available (with/without C-channel)

Atmospheric correction

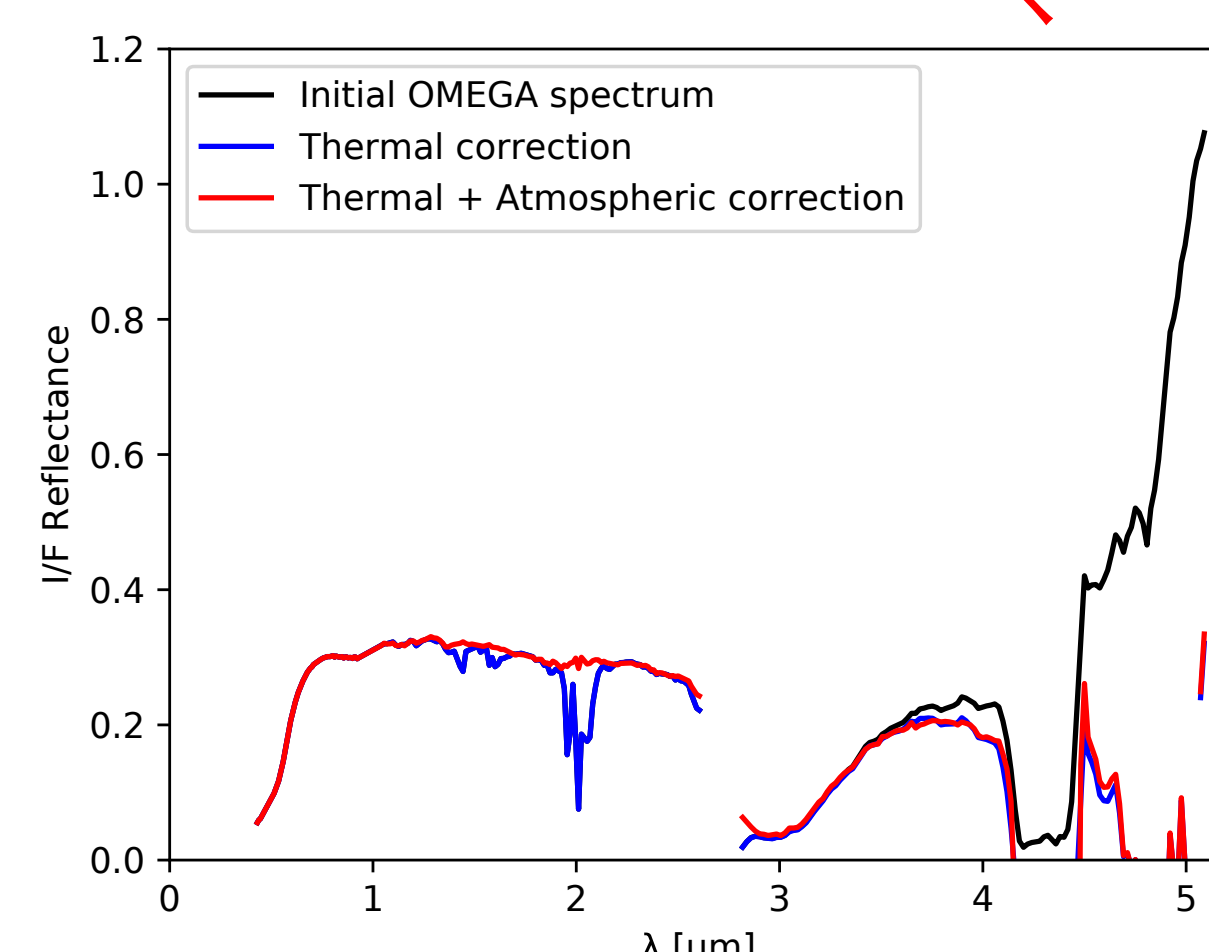
- Volcano-scan technique – *Scaling an empirical spectrum of the atmosphere using the CO_2 2 μm band.*
- 2 methods available

How simple is it to apply corrections?

```
# Atmospheric correction only
omega_corr_atm = od.corr_atm(omega)

# Thermal correction only
omega_corr_therm = od.corr_therm(omega, npool=10)

# Both Thermal & Atmospheric corrections
omega_corr = od.corr_therm_atm(omega, npool=10)
```



Simultaneous thermal & atmospheric corrections (recommended for using the L-channel)

MULTIPROCESSING

New

CONCLUSION & PERSPECTIVES

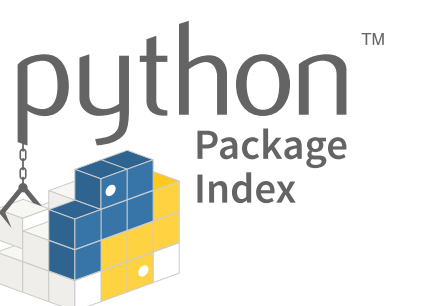
- New tool to handle, display and analyze OMEGA/MEx data.
- Complete Python alternative to the historical IDL software. Free & Open Source!
- Easier way to access OMEGA data:
➔ read binary files, apply corrections, interactive display & generate composite maps
- Already used in several studies.
- Article published in the *Journal of Open Source Software* (Stcherbinine et al., 2024).

THE OMEGA-Py MODULE



What is OMEGA-Py?

- Python 3 module dedicated to the scientific analysis of OMEGA data
- Available on GitHub at: <https://github.com/AStcherbinine/omegapy>
- And on PyPI: <https://pypi.org/project/omegapy>
- Current version: 3.2 – Official release
- Full online documentation: <https://astcherbinine.github.io/omegapy>



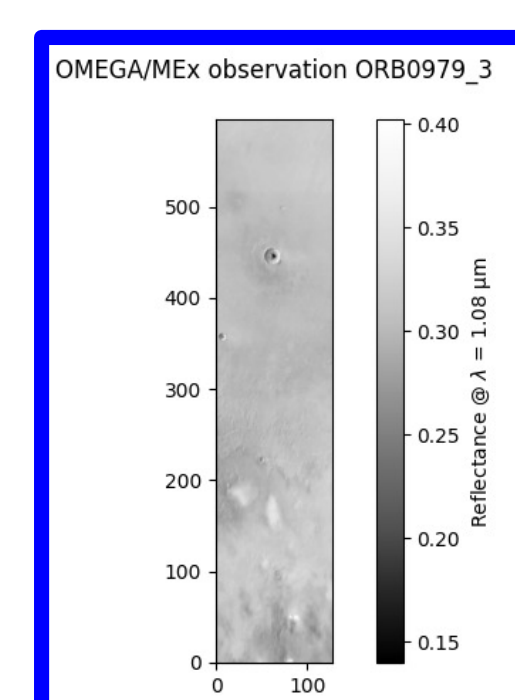
Why this module?

- The OMEGA dataset has acquired the reputation to be challenging to use...
- We aim to tackle this reputation with this all-in-one toolbox!
- Developed as an alternative to the historical *SOFT 10* IDL routines
- Easier handling of several OMEGA observations using OOP
- Built-in data correction & visualization functions
- Provide easier access to OMEGA data to a new generation of scientists

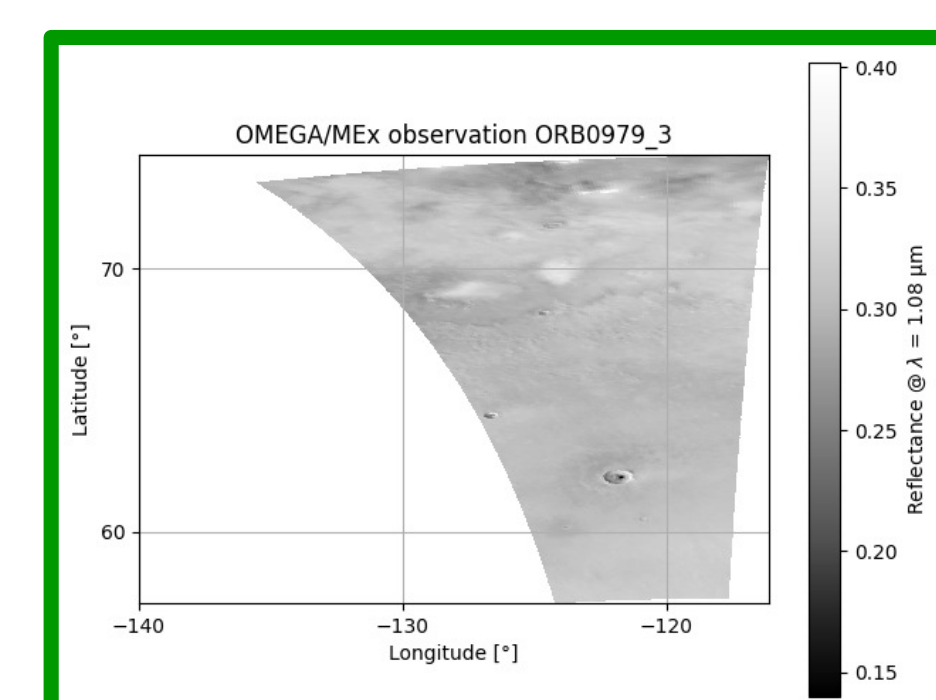


DATA VISUALIZATION

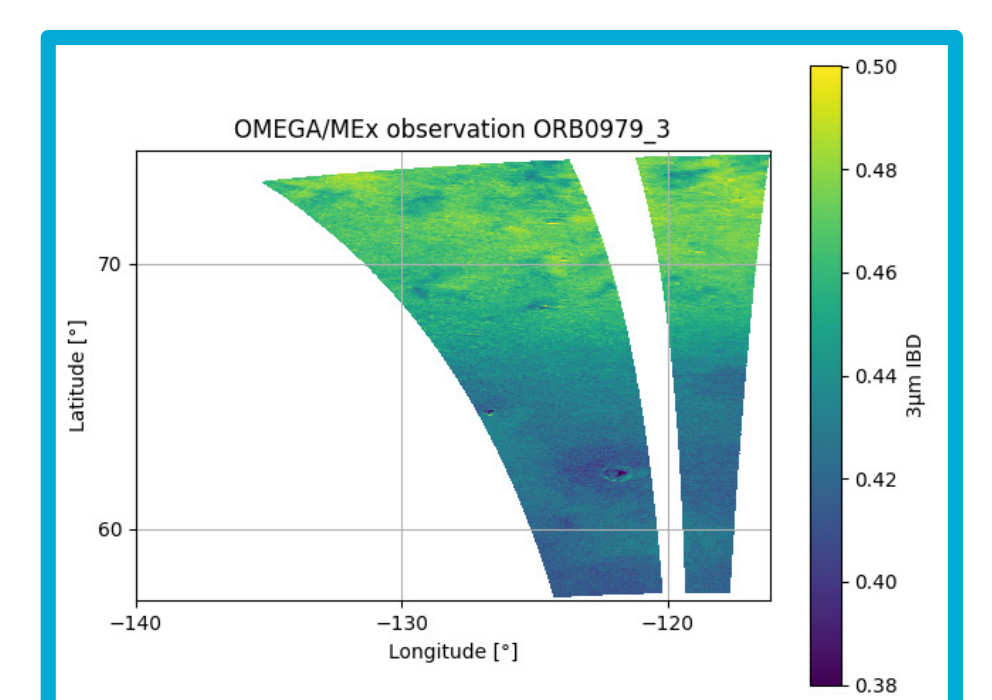
OMEGA-Py comes with a set of visualization functions, specifically developed for the OMEGA hyperspectral data. It includes equatorial and polar projection of the data, the generation of composite maps, the use of the specific geometries for the V, C and L channels, and a very useful interactive display to quickly explore the spectral and spatial diversity of an OMEGA observation.



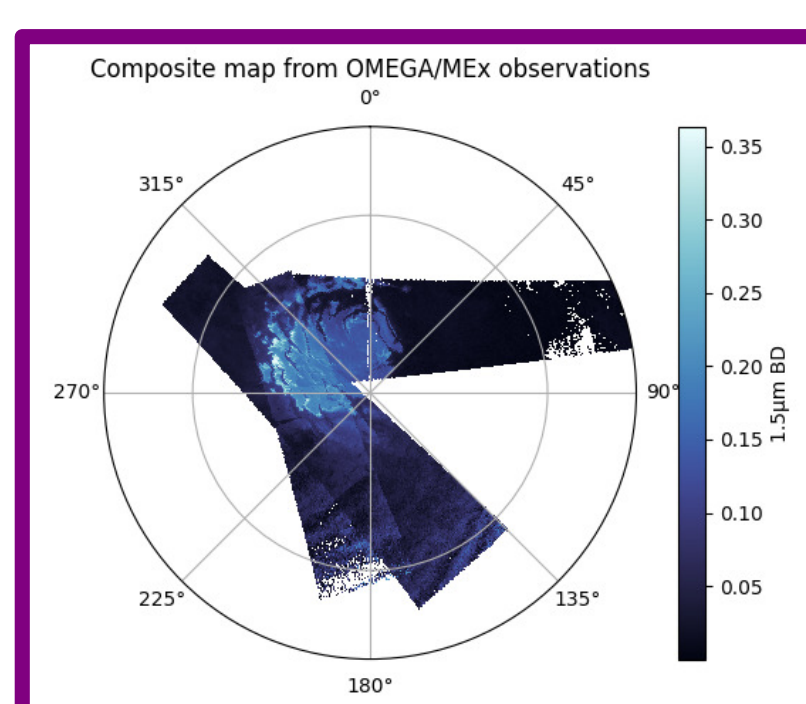
Reflectance – Non-projected



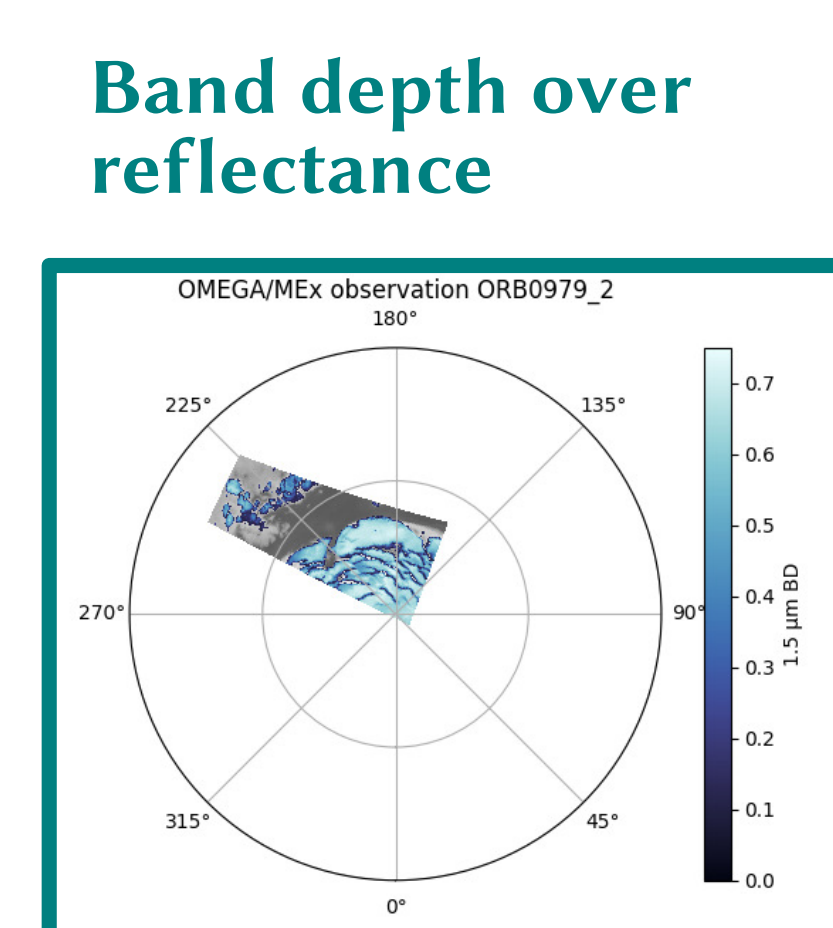
Reflectance – Projected



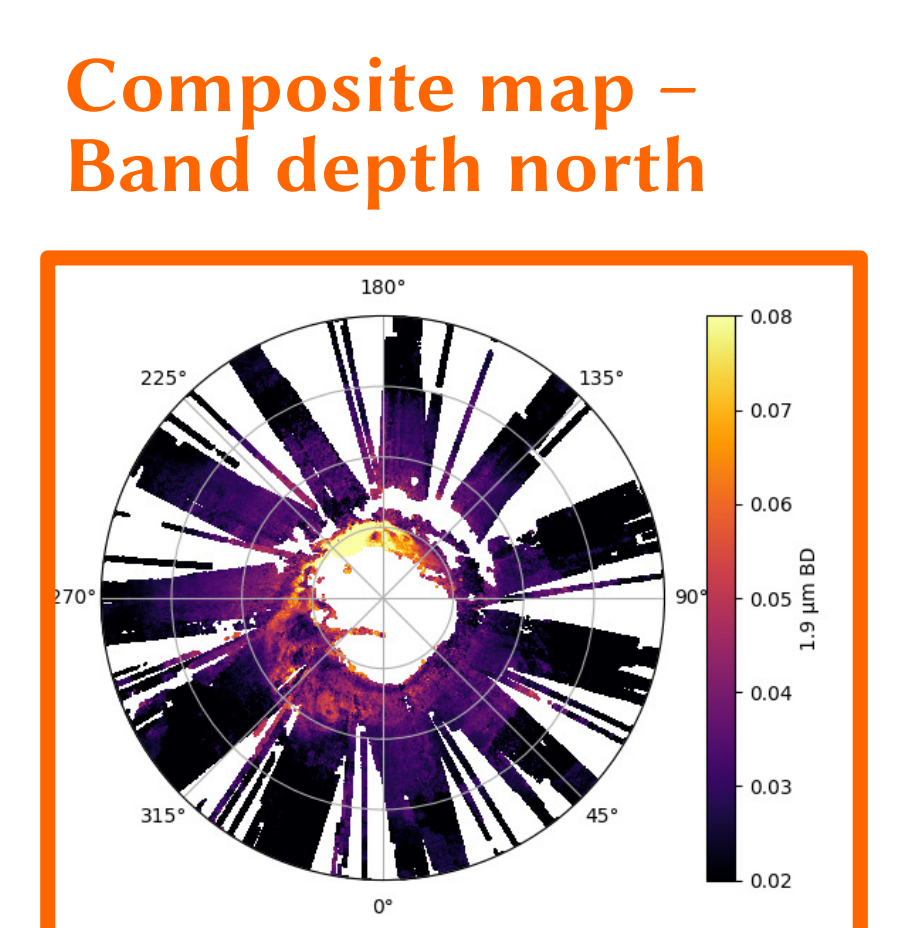
Band depth – Projected & Masked



Band depth – Polar projection

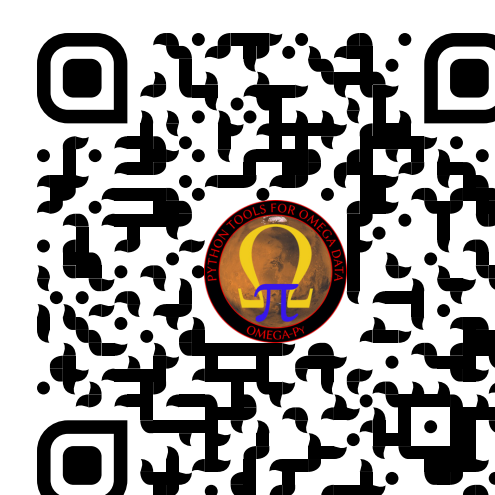
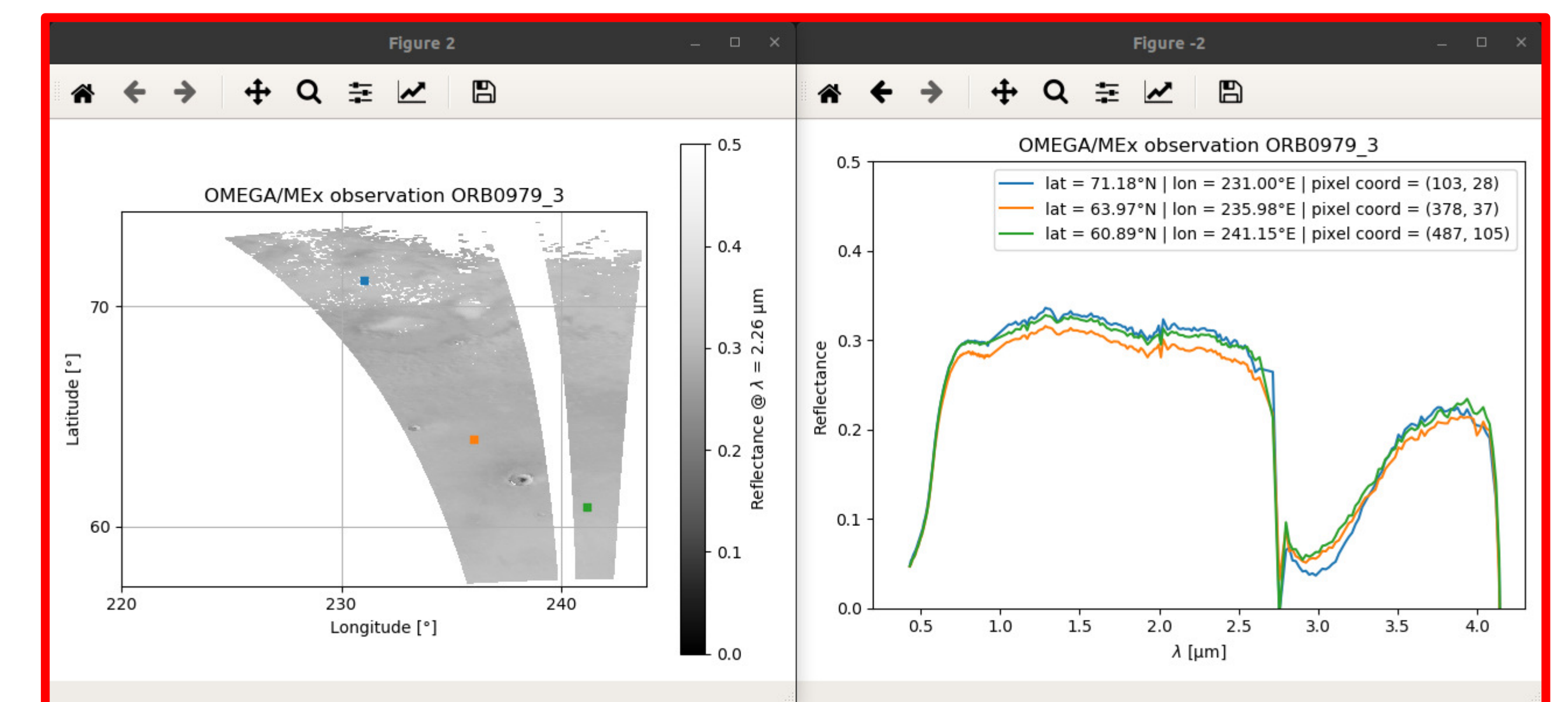


Band depth over reflectance

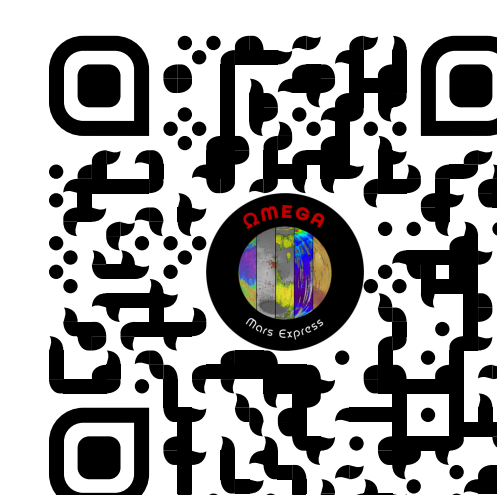


Composite map – Band depth north

Interactive display



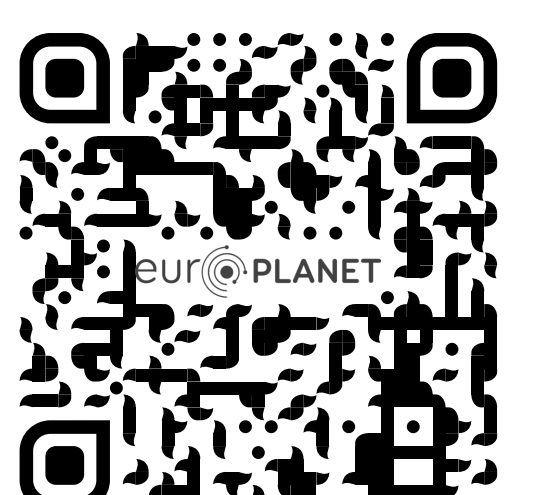
OMEGA-Py website & Online documentation



OMEGA website



JOSS article



EPSC-DPS 2025 Abstract 1434

Contact: Aurelien.Stcherbinine@irap.omp.eu