OMEGA-Py: A New All-in-One Python Solution for OMEGA/MEX Data

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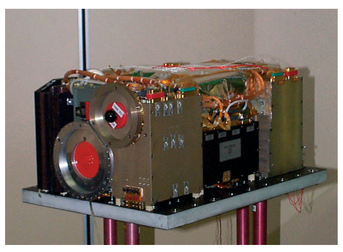
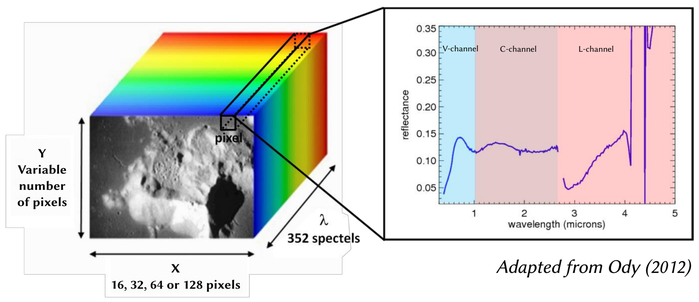
THE OMEGA INSTRUMENT

- *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)



Adapted from Ody (2012)

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: **3.0.6 – 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 obervations using **OOP**
- **Built-in data correction & visualization functions**
- Provide **easier access** to OMEGA data to a **new generation of scientists**

DATA IMPORTATION, HANDLING & CORRECTION

Data importation

```
In [2]: omega = OMEGAdata('0967')
7 files found :
 1 : /data2/opt/geomeg/data/product/ORB0967_0.QUB
 2 : /data2/opt/geomeg/data/product/ORB0967_1.QUB
 3 : /data2/opt/geomeg/data/product/ORB0967_2.QUB
 4 : /data2/opt/geomeg/data/product/ORB0967_3.QUB
 5 : /data2/opt/geomeg/data/product/ORB0967_4.QUB
 6 : /data2/opt/geomeg/data/product/ORB0967_5.QUB
 7 : /data2/opt/geomeg/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  sbyte:       4
       0 or less IR:   173073
 negative pixels VIS:    12402
anomalous pixels VIS:      100
saturated pixels VIS:      100
          spikes VIS:     3385

Computing data extraction and correction... [done]
```

```
In [4]: omega = OMEGAdata('0967_3', disp=False)

In [5]:
```

- Read L1B binaries to produce L2A data, simirarly 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

```
In [3]: omega
Out[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
```

New

- 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.

Data correction

Thermal correction

- Required to use the L-chanel (λ > 2.7 µm)
- 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

Simultaneous thermal & atmospheric corrections

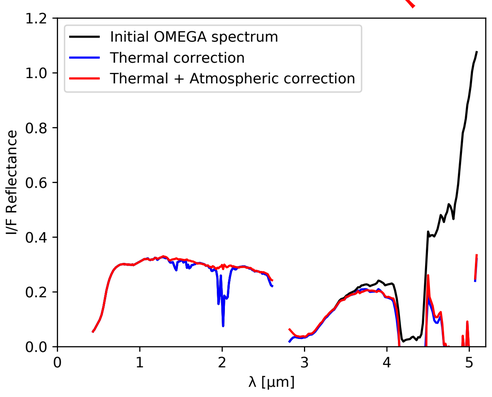
(recommended for using the L-channel)

MULTIPROCESSING

New

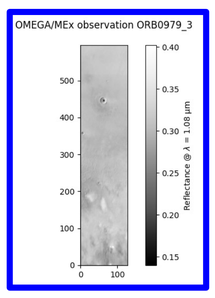
How simple is it to apply corrections?

```
# 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)
```

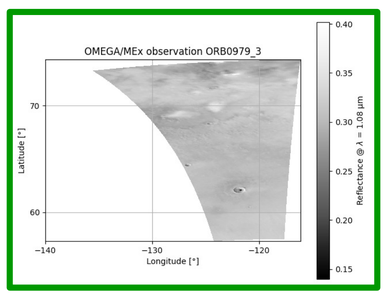


DATA VISUALIZATION

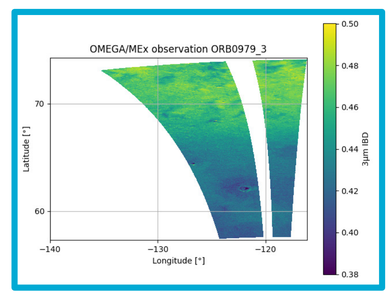
OMEGA-Py comes with a **set of visualization functions**, specifically developped for the OMEGA hyperspectral data.
It includes **equatorial and polar projection** of the data, the generation of **composite maps**, the use of the **specific geometries for the V or C/L channels**, and a very useful **interactive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



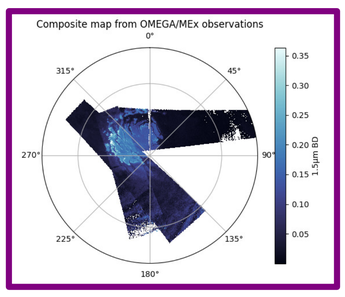
Reflectance – Non-projected



Reflectance – Projected

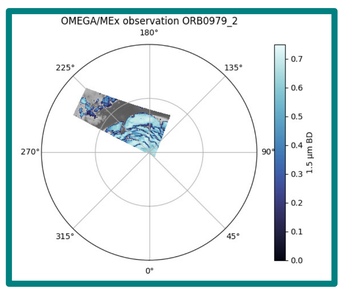


Band depth – Projected & Masked

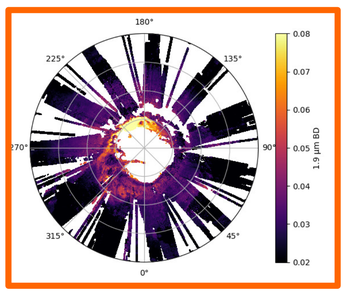


Band depth – Polar projection

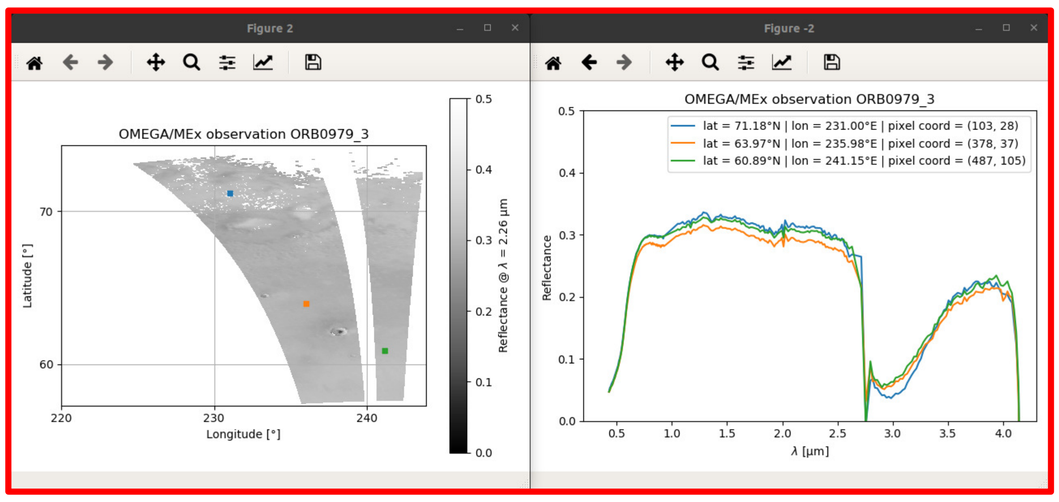
Band depth over reflectance



Composite map – Band depth north



Interactive display



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:
  ➡ *reading birary files, apply corrections, interactive display & generate composite maps*
- **Already used in several studies.**
- Publication in the *Journal of Open Source Software* currently under review.

OMEGA-Py website & Online documentation

OMEGA website

JOSS article

10th Mars Conference Abstract 3048

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