H2020-INFRAIA-2019-1

Europlanet 2024 RI has received funding from the
European Union's Horizon 2020 Research and Innovation Programme under

Grant agreement no: 871149

Deliverable D6.12

Deliverable Title:	**Global spectral parameters maps of Mercury**
Due date of deliverable:	31/05/2024
Nature:	R
Dissemination level:	PU
Work package:	WP6
Lead beneficiary:	DLR
Contributing beneficiaries:	-
Document status:	Final

Start date of project:	01 February 2020
Project Duration:	54 months
Coordinator:	Prof Nigel Mason, University of Kent

Deliverable D6.12 in WP6: VESPA VA focusses on making Mercury's visual/near infrared surface spectroscopic data available through the VESPA platform.
The data published in this deliverable are from the MESSENGER NASA mission, MASCS instrument, visible & near infrared channel (MASCS) and are the only remote datasets available to date to analyze the surface of Mercury.
The rationale is the preparation for the ESA/BepiColombo data. BepiColombo's nominal mission will start in late 2025 around Mercury. The author is part of the BepiColombo/MERTIS spectrometer team and participated in the NASA/MESSENGER MASCS spectrometer scientific analysis. This was an advantageous position, but also a burden. Familiarity with the instrument and with the data has facilitated the development of the deliverable. On the other side, BepiColombo already operated during its cruise mission, and MERTIS obtained precious data for its calibration and in-flight correction, but this also produced several issues that had to be solved. This forced us to realign the needs for this deliverable and forced to delay the delivery.

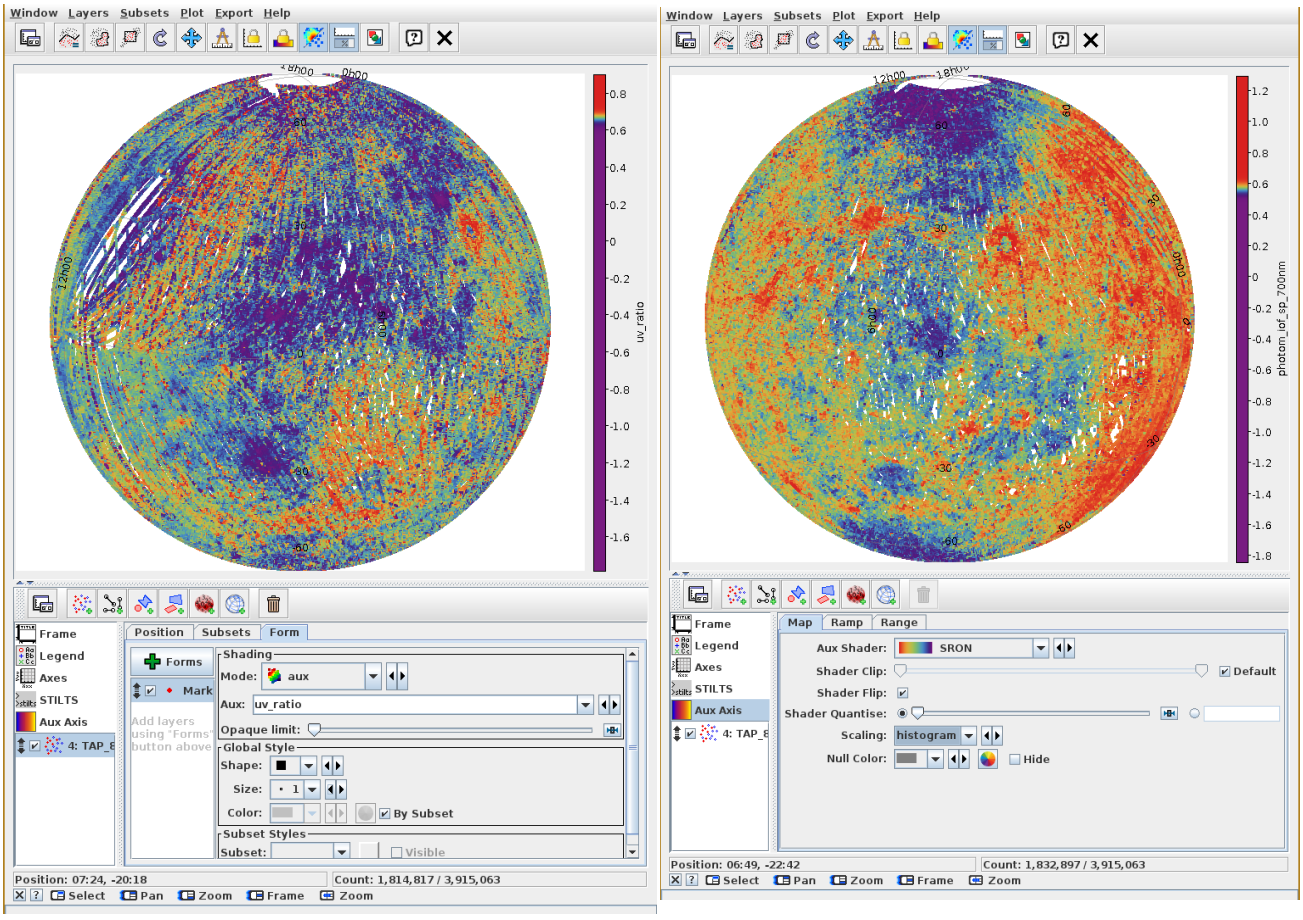

Figure 1: TOPCAT data from table mascs_vnir , visualizing 5M data points. (left) Ultraviolet/Visible ratio (uv_ratio). (right) photometrically corrected reflectance at 700nm

The dataset is publicly available at the NASA/PDS geosciences node, in the older NASA PDS3 standard, notoriously hard to access and work with. The data was completely converted to a relational database format (PostgreSQL) and ingested in GAVO/DACHS and is available at http://europlanet.dlr.de/tap, the table parameters being described here at mascs_vnir

endpoint. The data itself published via the TAP protocol is all the instrument metadata available. The spectra were sampled at several wavelengths from 300nm to 1000nm to give the user a way to readily visualize the surface reflectance with tools such as TOPCAT or Aladin (Fig.1) - this also provides the opportunity to search for spectra matching simple spectral parameters (albedo, band ratios…)

Owing to the importance of this data, the EPNCore table describes the individual spectra rather than the original spectral cubes, which have much larger footprints. Although demanding (5 million rows), this makes spectra accessible and searchable with the most resolved granularity level. For instance, users can query the service (from the VESPA portal or other TAP clients) on spectral parameters or local footprints (Fig. 2), allowing for cross-searches with other services in the field – for instance spatial footprints of identified units.

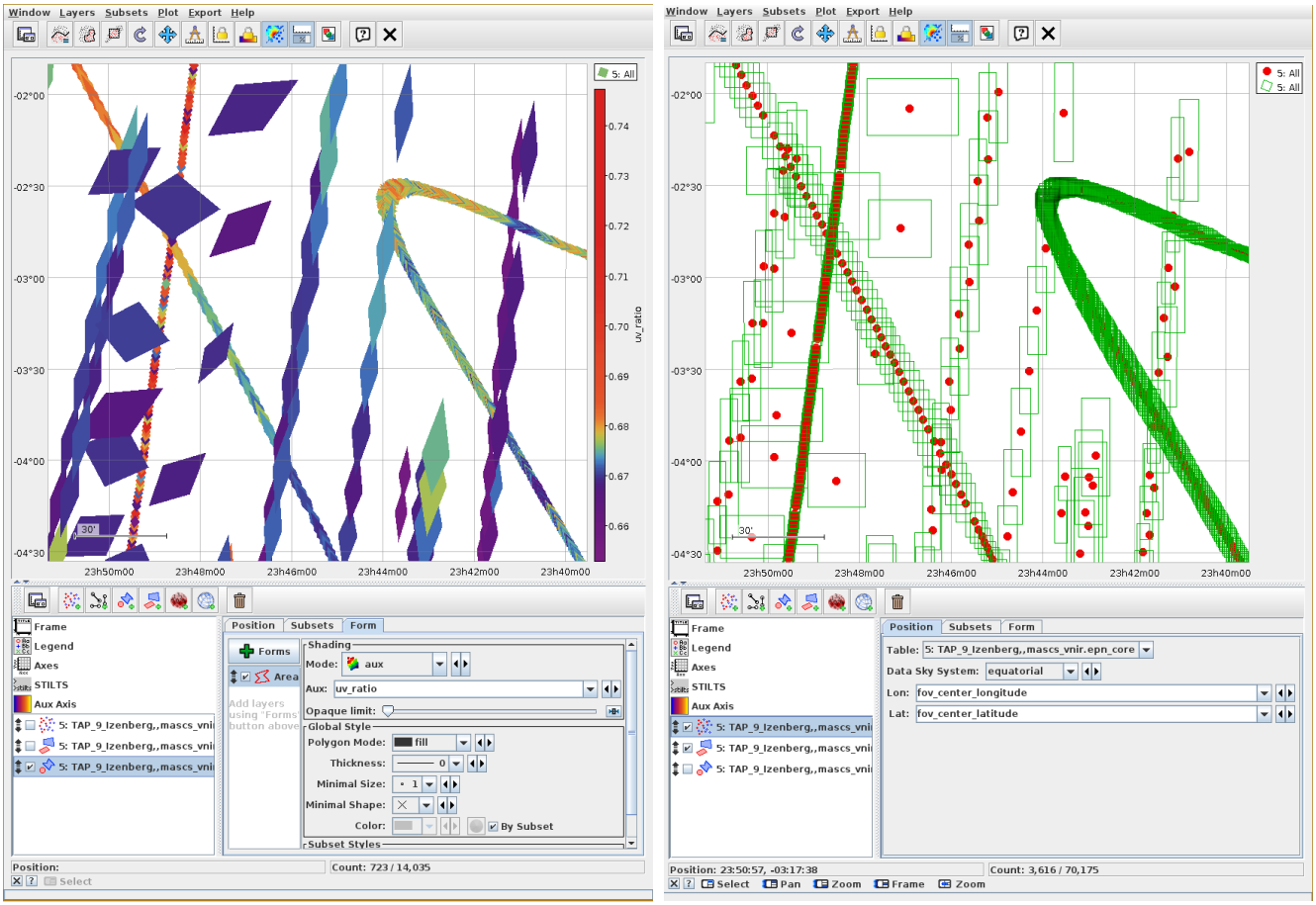

Figure 2: TOPCAT visualisation of data from table mascs_vnir . (left) UV ratio plotted within the actual instrument field of view (as polygons) in a region of interest. (right) same data, the center of the FoV and the bounding box are also provided for faster display and handing by more basic plotting tools.

To speed up access, the spectra themselves have been extracted from the original cubes and are accessible independently as VOTable at the URL http://europlanet.dlr.de:8080/data/mascs_vnir/ (this endpoint is not accessible directly and a file name is required in the URL, for example VIRSVD_ORB_11286_112941_DAT-Spectrum_82). These spectra can be visualised in VO tools such as TOPCAT or CASSIS, for instance from selection of table rows in the VESPA portal (Fig. 3).

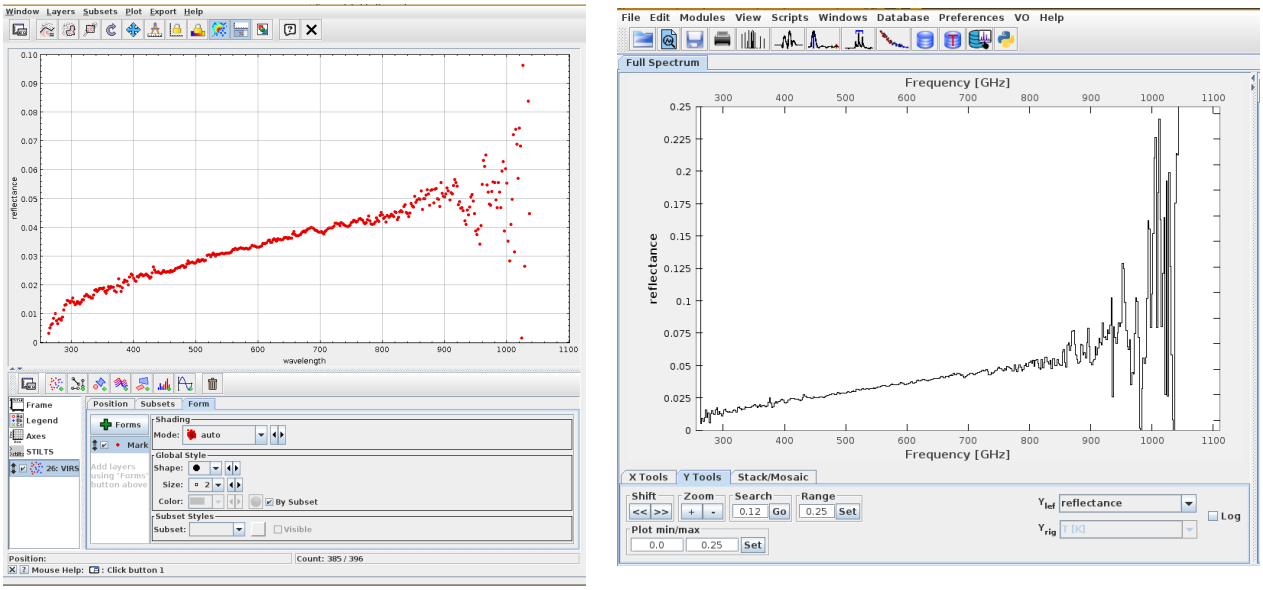

Figure 3: (left) example access to measurement spectra with TOPCAT (right) example access to measurement spectra with CASSIS.

Altogether, this is an unusual but very efficient way to access the data – they can be selected both from global cube properties (mission phase, season, instrumental mode, etc) and local characteristics (illumination conditions, S/N ratio, data range, etc), and individual spectra from different cubes/observing sequences are easily exploited together. Earlier, pre-VO, attempts to handle complex datasets in a similar fashion (e.g. with the Rosetta data) were very demanding and not as practical. This service demonstrates that the VESPA infrastructure now allows handling of imaging spectroscopy data in an optimized way.

The code and data descriptor needed to set up the data service are preserved in the voparis-gitlab instance. The repository contains the current GAVO/DACHS Resource Descriptor, along with a smaller data set to test the service.
An example query in Astronomical Data Query Language (ADQL) to extract the data described by Resource Descriptor is also provided. This can be used in any TAP interface (TOPCAT, VESPA portal…) or directly in the ADQL form of our DaCHS server: http://europlanet.dlr.de/__system__/adql/query/forms/.
The internal database schema and the query to extract the data fed to GAVO/DACHS are also present.
An example of the original data (PDS metadata label) is also present.

Explanation of Work & Overview of Progress

a) Objectives

- Facilitate the access to MASCS/VNIR dataset
- Expose supplemental parameter from the same data endpoint, that were not yet publicly available e.g. : photometrically corrected reflectance, spectral index (Ultraviolet/Visible ratio (uv_ratio), Visible ratio).

b) Explanation of the work carried in WP

- Write ad-hoc code to read MASCS/VNIR PDS3 dataset

- Plan the relational database structure to host the data in PostgreSQL
- Benchmarking the spectral storage in PostgreSQL
- Calculate the most appropriate spectral parameter
- Export the data from the internal database in tabular format for ingestion in GAVO/DACHS, around 1,6GB compressed
- Export all the 5M observations to Virtual Observatory (VO) Tables, around 150GB.
- Learn the required skill to manipulate data in GAVO/DACHS
- Learn the required skill to manipulate container technology
- Set up a URL endpoint behind the Apache webserver for the Table Access Protocol (TAP) endpoint and a separate one to serve the VO Tables

c) Impact to date

Initial test of the data service with the Mercury surface community are extremely positive, having unlocked a useful diagnostic dataset for Mercury that is currently used to prepare the laboratory studies to interpret the upcoming data from the BepiColombo mission.