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3D visualization of planetary data: the MATISSE tool in the framework of VESPA-Europlanet 2020 activity

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Abstract

MATISSE is a web tool allowing 3D visualization of planetary data. Here we discuss the new functions implemented on MATISSE to allow visualization of derived and high-level data, as well as the implementation of protocols to make it compatible with the planetary Virtual Observatory, developed under the VESPA-Europlanet2020 activity.

1. Introduction

The goal of the VESPA (Virtual European Solar and Planetary Access) activity, developed in the framework of the Horizon2020 Europlanet project, is the development of a Virtual Observatory for planetary data, in order to make them interoperable and facilitate its access, visualization and correlation [1]. A VESPA user interface (http://vespa.obspm.fr) is available to select planetary data from main databases (by means of specifically developed protocols, i.e. EPN-TAP) and includes many tools for analyze them.

The MATISSE (Multi-purpose Advanced Tool for Instruments for the Solar System Exploration) web-tool [2], developed by ASI-ASDC, allows the visualization of basic and derived data on shape models of planetary bodies. This operation is fundamental especially for minor bodies with irregular shape, since a cylindrical projection could be not sufficient for a straightforward data analysis. Here we discuss the functions implemented on MATISSE to analyze spectroscopic data and to derive high-level products, and present the activities in progress to integrate MATISSE with the VESPA interface.

2. New MATISSE functions

2.1 Radiance to reflectance conversion

Most of spectral and hyperspectral data are provided in radiance (level 1A), but especially in the visible and near-infrared spectral range reflectance spectra are more suitable to retrieve absorption features and infer the corresponding carrier.

This function converts spectral radiance in radiance factor (I/F), basing on the procedure explained in [3]: radiance is divided by a solar spectrum irradiance [4], convoluted with the spectral resolution of the VIR spectrometer [3] (only minor changes would be required to make the function suitable for other instruments), and multiplied for πd^2, being d the spacecraft solar distance expressed in Astronomical Unit. A reflectance image obtained by applying this function is shown in Figure 1.

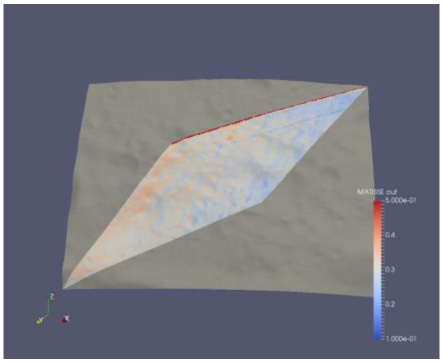

Figure 1. Reflectance image at 1.2 μm, obtained by converting a VIR radiance hyperspectral image of Vesta, and projected into MATISSE on the Vesta shape model.

2.2 Retrieval of band depths

Descriptors of band depths are fundamental to infer composition of a planetary surface or atmosphere. We implemented on MATISSE a function for retrieval of spectral descriptors of pyroxene's bands, centered at 1 and 2 μm and commonly found e.g. on many asteroids visited by space missions (Eros, Vesta).

The procedure is based on the approach by [5]. The two shoulders of each band are fitted by polynomial curves, whose local maxima represent the band boundaries. Continua are straight lines connecting the two band boundaries. Band center is calculated as the reflectance minimum after continuum removal; band depth as the complement to 1 of the ratio between measured reflectance and calculated continuum reflectance at the band center; band area as sum of differences between continuum and reflectance at each wavelength inside the band; band slope as ratio between the differences of shoulders' reflectances and shoulder's wavelengths, respectively; band width as difference between the two wavelengths corresponding to a half band depth.

2.3 Photometric correction

Photometric correction is necessary to remove influence of illumination and viewing angles from reflectance. We implemented on MATISSE a two-steps process of photometric correction, based on the approach described by [5-6]. The first step is the application of the Akimov disk function [7] to remove the influence of topography. The second step is the application of a phase function obtained by means of a statistical analysis, in order to retrieve the albedo at a defined phase angle (0° or 30°). Currently, phase functions retrieved for photometric correction of VIR [3] data of Vesta and VIRTIS-M [8] data of the Churyumov-Gerasimenko comet (Figure 2) are available on MATISSE.

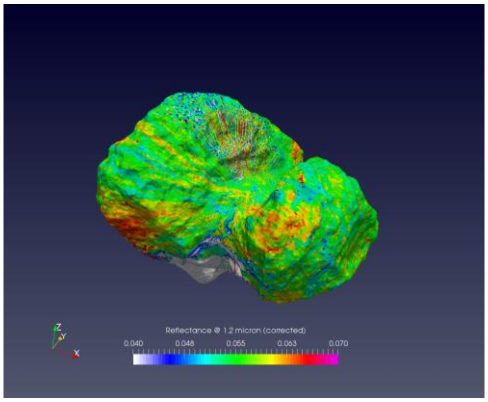

Figure 2: Photometrically corrected reflectance at 1.2 μm of Churyumov-Gerasimenko projected into MATISSE on its shape model.

3. MATISSE vs VESPA

We plan to interconnect MATISSE with VESPA VO tools and data services, which require the implementation of SAMP (Simple Application Messaging Protocol) protocol. We could implement the following possibilities:

1. MATISSE linked to the VESPA user interface, in order to visualize with MATISSE the data searched and selected from VESPA;
2. MATISSE linked with the APERICubes demonstrator (which is the tool currently used on VESPA for PDS file), together with the other VO tools currently present on VESPA;
3. MATISSE used to visualize the outputs from VO tools, in order to allow different visualizations of planetary data.

In all the three cases, the implementation of SAMP protocols on MATISSE is needed and is an operation in progress.

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