ANALYSIS OF MULTIANGULAR MESSENGER COLOR OBSERVATIONS OF HOLLOWS AT CANOVA CRATER, MERCURY

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Introduction: One of the major open science questions about Mercury surface processes and landforms is the nature of hollows, puzzling features identified on MESSENGER (MErcury Surface, Space ENvironment, GEochemistry, and Ranging, [1]) images [2]. hollows are 10 m to several km-sized shallow, irregular, flat-floored depressions characterized by bright interiors and haloes and found on crater walls, rims, floors, and central peaks [2,3]. Proposed explanations for the origin and formation of hollows envision the release of volatiles from the surface of Mercury [1] through processes like sublimation, desorption, sputtering, micrometeorite impacts and pyroclastic volcanism. Multi-band photometry of hollows at Dominici crater (1.2 °N, 232.5 °E) revealed absorption features attributed to Mg and Ca sulfides [4]. However, further compositional analyses at multiple locations on Mercury showed that a more complex mineralogy is required to explain the observed hollows spectra, which may be a mixture of sulfides and Cr, Ti, and Ni [5,6].

In this abstract, we focus on the analysis of multiangular Mercury Dual Imaging System (MDIS,[7]) wide angle camera (WAC) color images of hollows at Canova crater, Mercury (25.62°N, 3.75°W). The site was selected because its detailed geomorphological and compositional analysis is available in [5], hence allowing a direct comparison with our results. In addition, a relatively high (i.e. > 5) number of MDIS/WAC observations in multiple (i.e. 8) filters are available at this site, hence allowing to investigate both the spectral and photometric properties of hollows.

Methodology: We collected multiple MDIS/WAC images covering the hollows in Canova crater in 8 out of 11 filters. Filters A (700 nm), H (950 nm) and K (1020 nm) were neglected because there were not enough images for our analysis. Each image is processed with the ISIS software, by first attaching SPICE information through the *spiceinit* task and then applying the radiometric calibration through the *mdiscal* command. To deal with resolution differences, all images are downsampled to 665 m/px, and the task *phocube* is used to compute the local incidence, emission, phase and solar and spacecraft azimuth for each pixel within each image. Next, a sampling grid with a scale of 665 m is constructed (Fig. 1A). This scale has been selected because it is the resolution of the DTM, and hence of the photometric angle maps. For all observations in each filter, flux values and the photometric angles are collected at each sampling point (Fig. 1A, 1B). Finally, the data at each sampling point is fitted with a basic Hapke model and the Kasalaainen-Shkuratov models (KS1 to KS6 as defined in [8]). The fitted parameters are then used to correct each observation to a standard illumination and observation geometry. This allows to combine multiple images for each band: as shown in Figure (2B), after the photometric correction there is no visible brightness seam between the two images (Fig. 2A). This in turn allows to average flux values from multiple overlapping observations and obtain MDIS/WAC spectra at a potentially higher SNR.

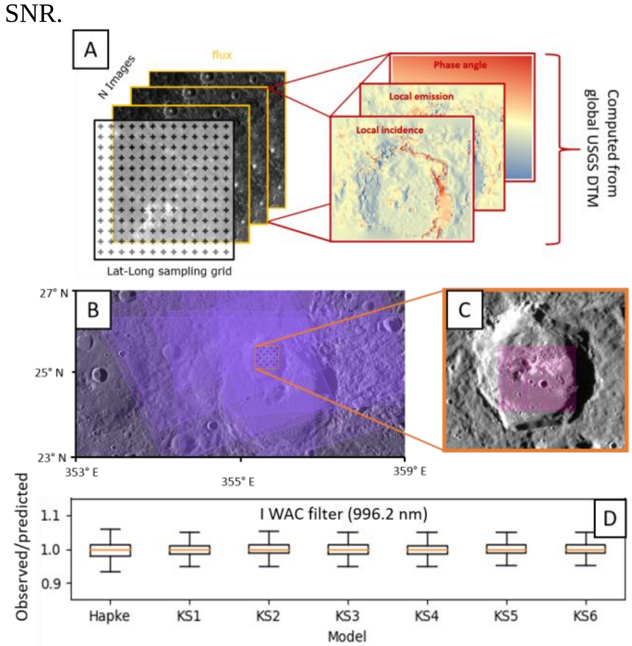

Figure 1 A) Sketch of the MDIS/WAC dataset. The flux is collected at each point of sampling grid from all images covering Canova crater and for each band. Along with the flux, also the photometric angles (only incidence, emission, and phase displayed for clarity) are collected. B) G-band images (violet, in transparency. C) The area under investigation (pink square). D) Box-plots of the ratio between the observed and predicted flux for each fitted model.

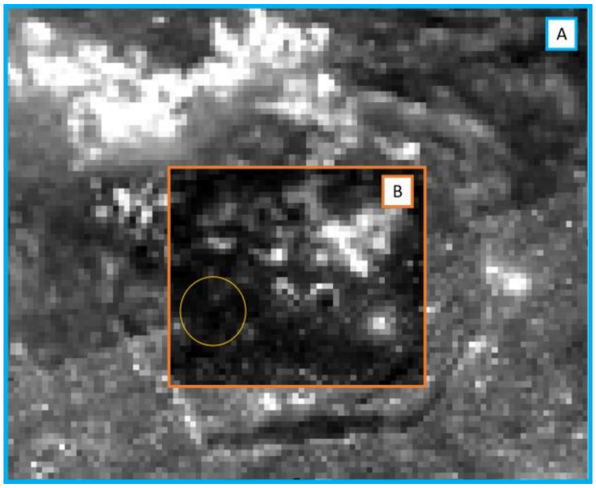

Figure 2 A) Mosaic of 2 uncorrected MDIS/WAC images. B) Mosaic of the same images in A) but corrected with a Hapke photometric model.

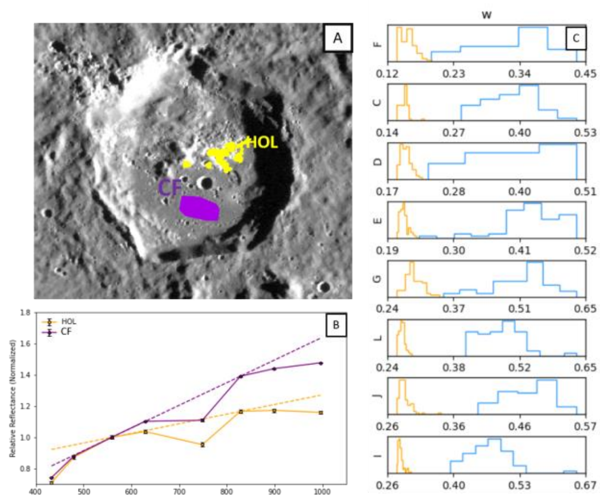

Figure 3 A) MDIS/NAC image of Canova crater showing the ROIs used to extract the hollows (HOL, yellow) and crater floor material (CF, purple) spectra, which are reported in panel B after normalization at 558 nm. C) Single-scattering albedo distribution for the hollows (blue) and crater floor material (yellow).

Results and discussion: The performance of our topographic correction are shown by the box-plots in Fig. 1D. On the y-axis we have the ratio of the observed vs predicted flux for the I (996.2 nm) band (we plot only 1 band for clarity, but the others give similar results). The fitted photometric models allow to reproduce the observed flux values with an error below 10% at 3σ, which is comparable with the radiometric accuracy of the MDIS/WAC datasets. In Fig. 3B we report the average relative reflectance spectra, normalized at 558 nm, for the hollows material ("HOL", yellow ROI in Fig. 3A) and the crater floor material ("CF", purple ROI in Fig. 3A). Consistently with the multi-band, MDIS/WAC, clustering-derived spectra from [5], hollows at Canova crater show an absorption between 600 and 800 nm and a lower spectral slope than the crater floor material. From the same ROIs we also extracted the fitted parameters for all the photometric models. In particular, the distribution of the Hapke single-scattering albedo parameter for both the hollows and the crater floor material is shown in Fig. 3C, where we can see that the two materials have clearly different distributions.

Conclusions

We analyzed multiple MDIS-WAC observations in 8 out of the 11 WAC filters showing hollows on the floor of Canova crater. These observation were used to fit a topographic correction for each point of a 665 m-scale grid, allowing to standardize all images and obtain high SNR spectra of hollows and the crater floor material. Consistently with previous works, the hollows show an absorption between 600 and 800 nm and a lower spectral slope than the crater floor material. In addition, we are investigating the model parameters for both materials in each band. A preliminary investigation already shows that hollows have a higher and more spread single-scattering albedo distribution than the crater floor material. This spectrophotometric characterization will be useful to further investigate these features with high-resolution DTMs, color images and spectra from the SIMBIO-SYS [9] instrument onboard BepiColombo. A more in depth spectroscopic and photometric analysis will be presented at the conference.

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