TOPOGRAPHIC CORRECTION OF HiRISE AND CaSSIS IMAGES. G. Munaretto¹,², M. Pajola², C. Re¹, A. Lucchetti³, G. Cremonese¹, E. Simioni¹, M. Massironi¹,². ¹INAF, Astronomical Observatory of Padova, Vicolo dell’Osservatorio 5, 35122, Padova, Italy (giovanni.munaretto.1@phd.unipd.it). ²Department of Physics and Astronomy “G. Galilei”, University of Padova, Vicolo dell’Osservatorio 3, 35122 Padova, Italy. ³Department of Geosciences, University of Padova, Via Giovanni Gradenigo, 6, 35131 Padova, Italy

Introduction: The topographic correction of satellite images has to be applied to disentangle albedo features from illumination effects induced by topography and perform spectrophotometric studies of surface features based on multi-wavelengths datasets. Topographic shading is usually modelled through a function of incidence, emission and phase angles called disk function [1]. We consider four disk functions that are widely used in planetary photometry: the Lambert [2,3], Lommel-Seeliger [4], Akimov [5] and the Minnaert disk functions [2,3,6]. We test and evaluate their performances in removing topographic shading from High Resolution Imaging Science Experiment (HiRISE, [7]) and Colour and Surface Science Imaging System (CaSSIS, [8]) images.

Dataset: We initially focused on removing topographic shading from the publicly available orthoimage of HiRISE observation ESP_029331_1645, shown in Fig. (1A), depicting bedrock outcrops in the slopes of Eos Chasma (-15.422°, 309.554°). We used the available HiRISE digital terrain model (DTM) of the site as shape model of the surface and derived observation parameters from SPICE kernels to compute i) local emission (Fig. 1B) and ii) incidence (Fig. 1C) angle maps for each pixel of the DTM, following the approach of [2].

Methods: The orthoimage was radiometrically calibrated to I/F units using the offset and scaling factors reported in their PDS labels and atmospherically corrected by subtracting the I/F of the darkest shadowed pixel. We applied the topographic correction with the Lambert, Lommel-Seeliger, Akimov and Minnaert disk functions using the previously obtained incidence and emission angle maps. To evaluate the performance of all corrections and select the best one, we fitted the corrected reflectance profiles of Fig. (2) with a linear model and selected the flattest one, i.e. where most of the dependence from the incidence angle has been removed by the correction. This procedure was then applied to CaSSIS orthoimages and DTM of the central peak of Hale crater, (−35.7° N, 323.5° E), both obtained by processing CaSSIS stereo pairs through the 3DPD photogrammetric pipeline [9].

Figure 1: A) HiRISE orthoimage of Eos Chasma. B) Emission and C) incidence angle maps. D) Corrected orthoimage. Red arrows indicate where significant topographic shading has been removed.

Figure 2: topographically corrected values of I/F versus incidence angle, for each disk function.
Results: The Minnaert disk function always achieves the best correction for both the HiRISE and CaSSIS orthoimages. A comparison of the original and corrected images is shown in Fig. (3). The topographic correction removes brightness differences induced by topography, which are seen in Figures (3A,B), returning more uniform corrected images but preserving albedo features, such as the sand flows indicated by yellow arrows in Figures (3C,D). This is also shown quantitatively by the reflectance profiles in Figures (3E,F). The reflectance profiles retrieved from the corrected images (red lines) are always flatter than their counterparts in the original images (black lines), for both the HiRISE and CaSSIS cases.

Conclusions: the topographic correction can be a useful tool to remove topographic shading from satellite images. The resulting corrected images, which are seen in Figures (1D, 3C and 3D) can now be used for spectrophotometric analyses of surface features using multi-wavelengths datasets. Validation of the topographic correction and its applications to photometric studies of Martian surface features will be presented at the conference.

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