PROCESSING OF PLANETARY IMAGE DATA (HRSC): GIS-BASED PHOTOMETRIC CORRECTIONS. G. Wulf[1], S. van Gasselt, S. Walter, G. Neukum, Institute of Geosciences, Freie Universitaet Berlin, Germany ([1]gerwin.wulf@googlemail.com).

Introduction: Remote Sensing image data are usually affected by various unwanted effects due to technical characteristics of the employed optics and sensors as well as to exterior effects such as atmospheric and photometric characteristics. While, in general, optical distortion effects are handled during radiometric correction using ground-based calibration data, atmospheric effects have to be treated separately and need to be considered in the context of performing photometric corrections. Apart from illumination and observation conditions, i.e., geometries, the terrain geometry plays an important role as solar incidence and phase angles can change significantly during mapping. In order to cope with such photometric effects (assess/quantify effects and correct data), a variety of software implementations for planetary image data have been established (USGS ISIS2 and 3 packages, VICAR routines). The rather cumbersome procedures have led to generally avoiding photometric corrections during systematic data processing. Apart from the geometric dependences, i.e. observation, illumination and terrain geometry, the spectral intensity of a given surface pixel is strongly controlled by surface properties (e.g. roughness, grain size, porosity, composition) which can vary on a small scale. Navigation data for each pixel, as obtained from NAIF/SPICE, determine the position of the sun and the imaging platform and instrument with respect to the observed surface, whereas terrain model data as derived from stereo or altimetry data decribe the observed and illuminated surface geometry at a given time. To account for such variations in spectral intensities several photometric functions have been employed to correct such issues ranging from rather simplistic models parameterized by the incidence angle only to complex multi-parameter models that additionally take into account certain surface properties. Application of such photometric functions provide improvements of image data with respect to pixel intensities and allow the correction of these data to a common reference geometry and observation conditions. Normalized image data permits substantial improvements to combine and form a homogeneous data mosaic without such photometric effects.

Methodology: The goal of this work is to be able to load planetary raster image data into a standard GIS environment and perform selected corrections with user-defined parameterization so that photometric effects are minimized and subsequent image mosaicking by performing histogram matching and additional (non-photometric) color corrections and seam blending lead to best-possible results. We set up an environment which allows performing end-user photometric corrections by implementing basic raster-tools routines within a ArcGIS by ESRI. Mars Express High Resolution Stereo Camera (HRSC) forms the data basis for which a proper selection of the 'correct' function and user-defined parameterization is of utmost importance in order to be able to create color-image mosaics. The HRSC instrument is a pushbroom scanning device with nine CCD line detectors which has been operating in an elliptical orbit about Mars since 2004. The instrument provides high-resolution stereo image data with a pixel scale up to 12.5 m with a panchromatic nadir-looking channel, four colour channels and along-track triple stereo. The stereo performance of the instrument allows for derivation of high-resolution digital terrain models with a scale up to 50 m/px. In the course of this work we make use of the HRSC image data and terrain model derived from the stereo channels. Additional auxiliary geometric information, i.e. incidence angle/azimuth and emission angle/azimuth, are generated by making use of the NAIF/SPICE toolkit using reconstructed orbit data. For the derivation of correct geometries and correction factors we use standard Arc-GIS tools and extensions, for slopes and aspects, and several new procedures using the model builder function with map algebra routines to prepare the data basis for subsequent photometric corrections (see figure 1).

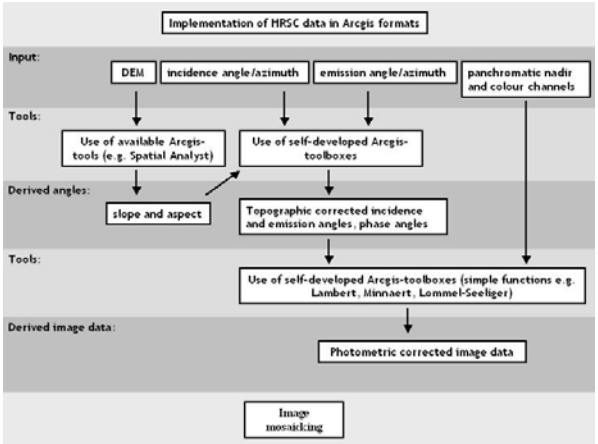

Figure 1: Flowchart describing the general procedures and work flow.

As a test bed, we have implemented simple photometric models, such as Lambert, Minnaert [1] and Lommel-Seeliger [2]. More sophisticated models, such as Hapke photometric function [3-6], will require a thorough knowledge of the surface properties and more complex mathematics and will not be treated initially. However, it has been shown [7] that for planetary surface more simple models, such as Minnaert, provides good results (see figure 2).

We have successfully implemented the basic photometric routines and the ArcGIS environment has shown to be capable of dealing with large planetary data sets in an efficient way. Once the angle conversions from SPICE and the proper terrain geometry has been defined, subsequent calculations and corrections are performed automatically using the Model Builder routines. The current work flow will significantly support the choice of a reasonable parameterization not only for nadir observations but also for HRSC colour data, for which phase angles and wavelength parameters still need to be established.
Results and procedures of this semi-automatic process are incorporated into the systematic data processing workflow for the corrections and mosaicking of HRSC image data which will be established using non-interactive routines outside any GIS and within a VICAR/ISIS environment allowing exchange of data between different processing levels.

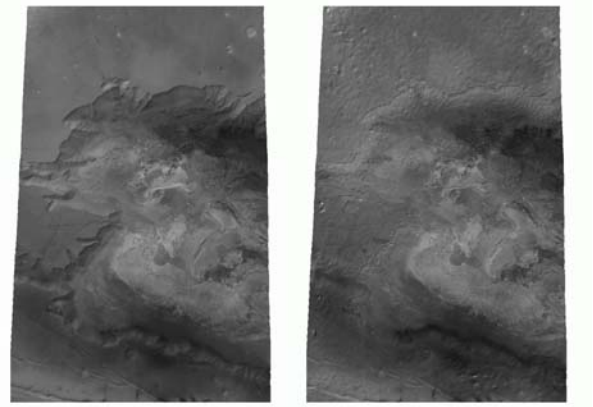

Figure 2: Part from the HRSC orbit 1235 (Valles Marineris): nadir image before (left) and after (right) photometric correction (Minnaert, k=0,5).

References:

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