DIGITAL TERRAIN MODELS OF MATHILDE AND THE MOON. J. R. Weirich[1], E. E. Palmer[1], and D. L. Domingue[1], [1] Planetary Science Institute 1700 E. Fort Lowell, Suite 106, Tucson AZ, 85719, USA..

Introduction: Digital Terrain Models (DTMs) of asteroid Mathilde and three regions of the Moon are now generated. DTMs can be used for a variety of scientific inquiries, such as heights of features, slope calculations, pixel-by-pixel emission and incident angles, and overlaying images over the DTM to bring out geologic features. [1] is an example of this type of inquiry. These models were constructed using the best imagery currently available and the software suite Stereophotoclinometry (SPC) [2, 3]. SPC solves for both topography and albedo, so realistic looking images can be generated from the model (Figures 1 and 2).

For Mathilde, the shape model (i.e. global DTM) contains data from the NEAR mission. For the Moon, the regional DTMs (each 50-100 km^{2}) contain data from the Lunar Reconnaissance Orbiter (LRO) mission. These areas include a portion of the lunar swirls Ingenii and Reiner Gamma, and a portion of Karpinskiy crater.

Imagery:

Ideal Image Suite. An ideal image suite for SPC contains a variety of zenith and azimuth angles, as well as illumination angles. It consists of four moderate emission images (30-45°) with azimuth angles separated by 90 degrees (e.g. N, S, E, W), as well as a fifth low emission image (i.e. zero degrees from zenith). For the illumination angles, we desire the sun to be on opposing sides (i.e. E and W) as well as a near-noon image. The near-noon image can constrain the albedo.

Mathilde. The NEAR flyby of asteroid Mathilde did not provide an ideal image suite; however the available images are sufficient to create a DTM. Three of the five viewing perspectives (e.g. E, W, and nadir) are available in the data set. The NEAR encounter lasted less than an hour, and during that time no rotation of the asteroid was observed. Hence, only one illumination angle was obtained. We used 120 images from the Mathilde flyby, with a minimum pixel size of 148 m/pxl.

Moon. The LRO mission mapped the surface with a line scanning imaging system in a polar orbit, so the viewing geometries are all in E-W or nadir directions. A variety of illumination angles are available, limited only by the latitude of the region. Despite only having three of the five preferred viewing perspectives, the resulting DTM has few differences when compared to images. For the lunar regions, we used between 17 and 29 images from the Narrow Angle Camera (NAC) for each DTM. These images have a pixel size that ranges from 0.5 to 1.9 m/pxl.

DTM descriptions:

Mathilde. The Stooke shape model [4] of Mathilde was used as the starting shape. Figure 1 shows a comparison of the Stooke model, a NEAR image, and the SPC model. The SPC model is a major improvement over the limb-based Stooke model. However, there are many noticeable differences between the image and model, especially the portions on the right and lower right of the figure. The shape model has a grid spacing of 6 m, but the model only represents the best imagery available at that location (best is 148 m). Hence, in all areas the data is oversampled.

Moon. Ingenii and Reiner Gamma are regions on the lunar surface that contain lunar swirls (bright albedo markings that swirl across the surface regardless of topography). The DTMs cover both the dark and light portions of the swirls. The Ingenii DTM is located at 35.8° South latitude and 161.8° East longitude, and covers a 10 x 10 km box. The Reiner Gamma DTM is located at 7.0° North latitude and 59.2° West longitude, and covers a 7 x 7 km box.

The Karpinskiy DTM extends from the northern rim to a bit south of the large fracture on the floor. This fracture can be seen at the bottom of Figure 2. The Karpinskiy DTM is located at 73.7° North latitude and 167.6° East longitude, and is a 5x20 km rectangle.

All lunar DTMs are at 5m/pxl. Additionally, we have generated DTM pixel-by-pixel data for I/F, phase, incident, and emission angles for each image using a technique described by [1]. An ISIS cube is available for each image of these regions as well as the Tsiolkovsky region. Each cube has four layers; one for each of the photometric angles and one for the reflectance value. The lunar ISIS cubes of the two swirl regions have been used to examine the photometric and textural properties of on- and off-swirl areas [5].

References: [1] Domingue et al. (2018) Icarus 312, 61–99. [2] Gaskell R. W. (2008) MAPS 43, 1049-1062. [3] Palmer, E. (2016) *Earth & Space Sci*. 3, 488–509. [4] Stooke, P. (2016) NASA PDS. [5] Domingue et al. LPSC 50, this issue.

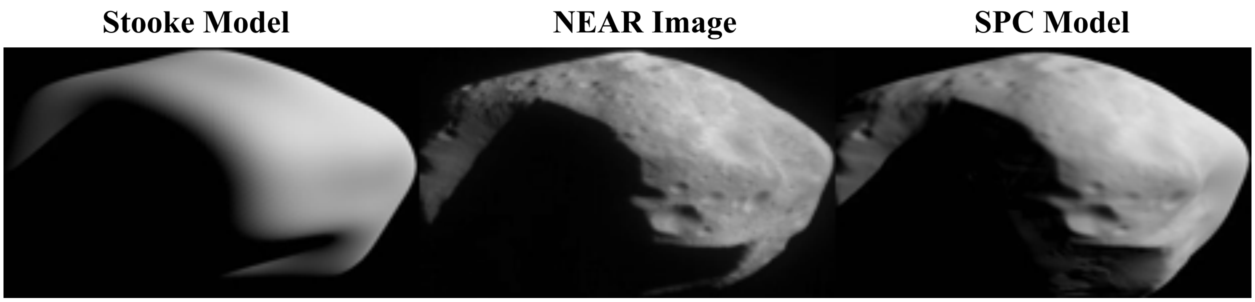

Figure 1. Shape model (i.e. global DTM) of asteroid Mathilde. This is good quality for a single flyby.

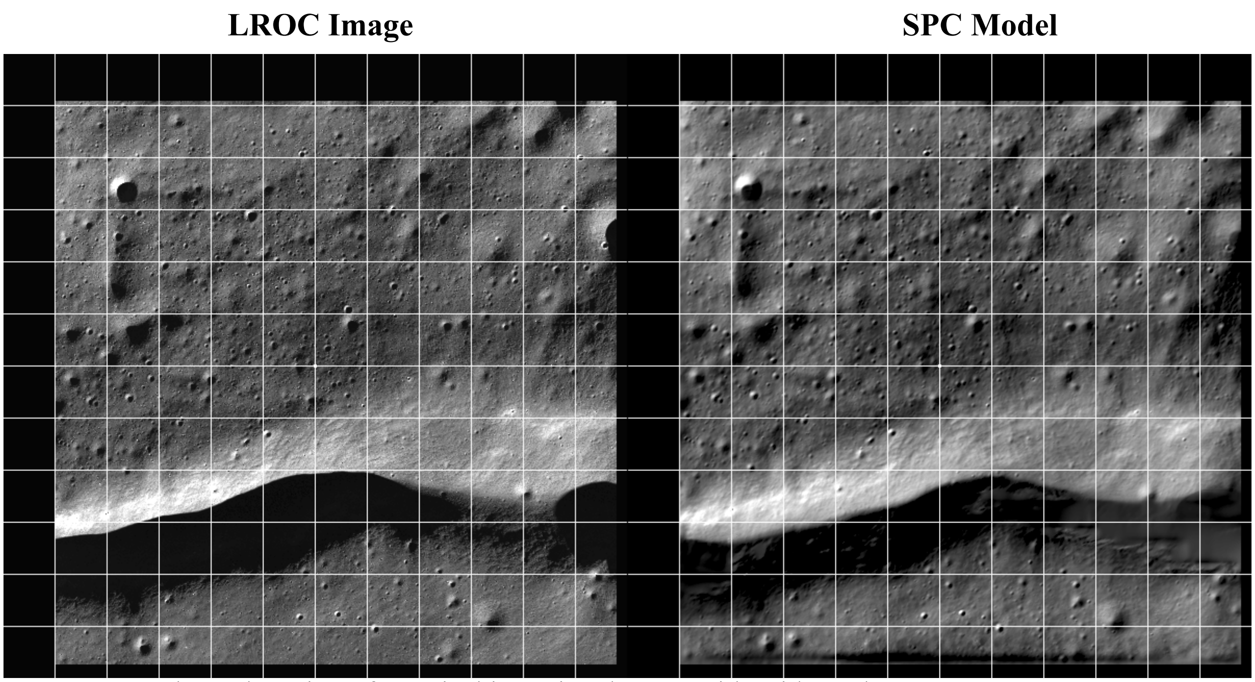

Figure 2. 5x5 km subsection of Karpinskiy regional DTM with grid overlay.