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# Topography of Mercury: A global model from MESSENGER orbital stereo mapping

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## 1. Introduction

In March 2011, the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) spacecraft was inserted into orbit about Mercury [1]. The spacecraft is equipped with the Mercury Dual Imaging System (MDIS) [2], which consists of a wide-angle camera (WAC) and a narrow-angle camera (NAC) coaligned on a pivot platform. MESSENGER has acquired more than 200,000 images from orbit. Because of MESSENGER's highly eccentric orbit and high northern periapsis, the northern hemisphere is typically covered by WAC, whereas the southern hemisphere is covered by NAC images. By tilting the camera, MDIS has also obtained stereo images, which can be used to generate digital terrain models (DTMs). The stereo DTMs are particularly important for the southern hemisphere, most parts of which are out of range of MESSENGER's Mercury Laser Altimeter (MLA). The DTMs in the northern hemisphere may complement the laser altimeter model to fill gaps between widely spaced MLA tracks at low latitudes.

## 2. Methods

The stereo-photogrammetric processing for Mercury is based on a software suite that has been developed within the last decade and has been applied successfully to several planetary image data sets [3-6]. The suite comprises photogrammetric block adjustment, multi-image matching, surface point triangulation, DTM generation, and base map production.

## 3. Stereo Coverage

We selected all images that have a resolution better than 600 m/pixel (~102,000 images in total). However, most images have resolutions better than 250 m/pixel (mean image resolution: 210 m/pixel). We defined suitable conditions (Table 1) to identify the stereo, which shows that 90% of the surface can be reconstructed with at least threefold stereo. For practical reasons we divided the global stereo coverage into 15 tiles that conform to the quadrangle scheme proposed by Greeley and Batson [7].

| Parameter | |
|---|---|
| Differences in illumination | 0–10° |
| Stereo angle | 15–45° |
| Emission angle | 0–55° |
| Incidence angle | 5–75° |
| Phase angle | 5–180° |

Table 1. Stereo conditions used for stereo processing.

## 4. Results

Each tile contains between 3000 and 6500 individual images. Approximately 55,000 images have been used to date. We first corrected for errors in the nominal navigation (pointing and position) data using a photogrammetric block adjustment. This step improved the three-dimensional (3D) point accuracy in all tiles from about ±800 m to about ±65 m. Next, about 115,000 individual image matching runs were carried out to yield ~23 billion object points. The mean ray intersection error of the ground points was ±55 m. Only triple-overlapping images were used for the matching. Then, we generated a DTM for each tile with a lateral spacing of 192 pixel/degree (~222 m/pixel) and a vertical accuracy of about 50 m. Finally we merged all DTMs, which resulted in a topographic model that covers about 80 percent of Mercury's surface (Figure 1a). Gaps (white areas in Figure 1a) in current stereo coverage as well as from current processing status were interpolated for a complete representation (Figure 1b). An updated version of this model will be presented at the conference.

# References

[1] Solomon S.C et al.: Mercury after six months of MESSENGER orbital observations, EPSC-DPS Joint Meeting Abstracts and Program, abstract EPSC-DPS2011-430, 2011.

[2] Hawkins S.E., III, et al.: The Mercury Dual Imaging System on the MESSENGER spacecraft, Space Sci. Rev., 131, 247–338, 2007.

[3] Gwinner K. et al.: Topography of Mars from global mapping by HRSC high-resolution digital terrain models and orthoimages: Characteristics and performance, Earth Planet. Sci. Lett., 294, 506–519, 2010.

[4] Oberst J. et al.: The morphology of Mercury's Caloris basin as seen in MESSENGER stereo topographic models, Icarus, 209, 230–238, 2010.

[5] Preusker F. et al.: Stereo topographic models of Mercury after three MESSENGER flybys, Planet. Space Sci., 59, 1910–1917, 2011.

[6] Scholten F. et al.: GLD100 - the near-global lunar 100 meter raster DTM from LROC WAC stereo image data, J. Geophys. Res., 117, E00H17, 2012.

[7] Greeley, R. and Batson, G.: Planetary Mapping, Cambridge University Press, 1990.

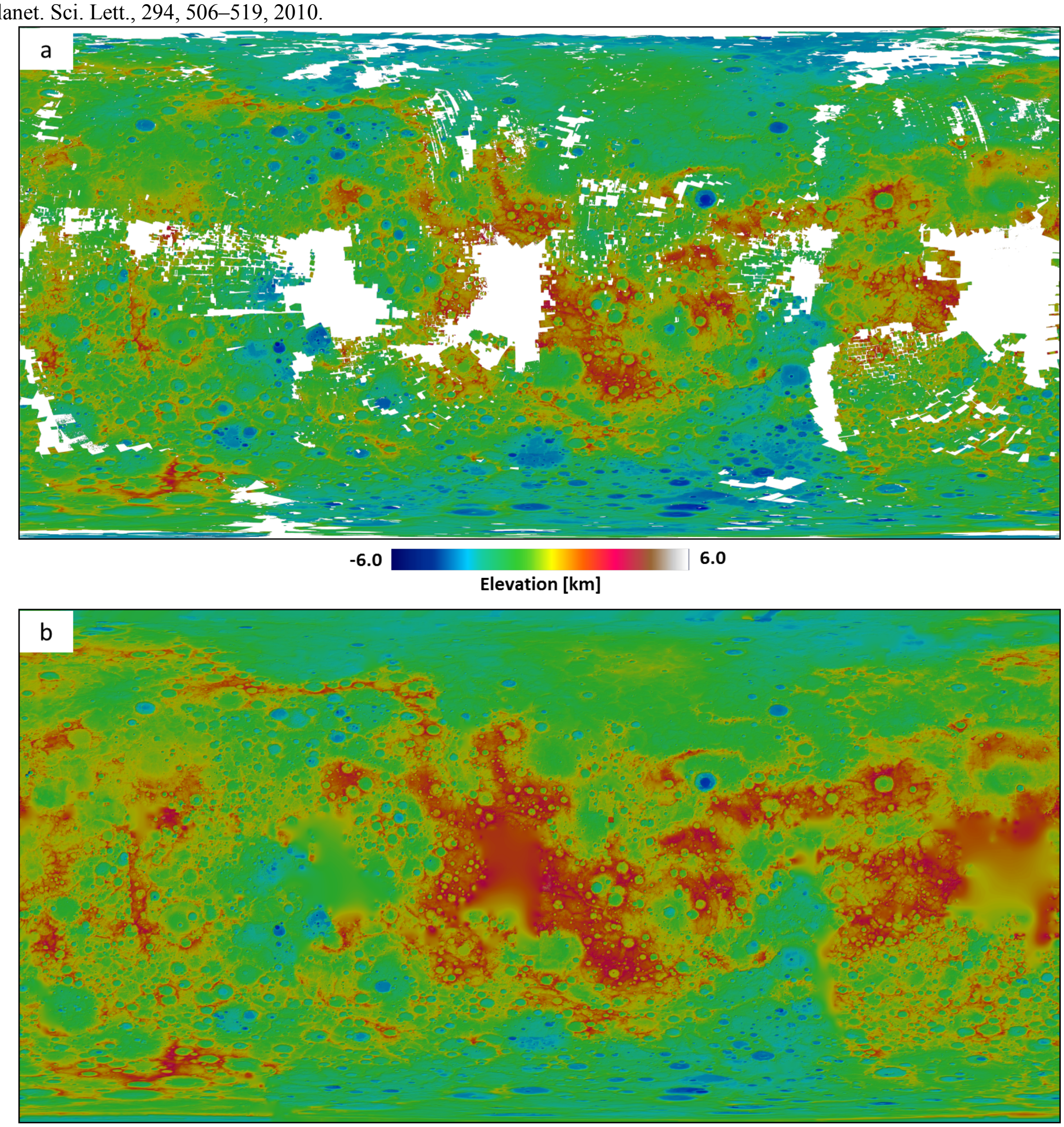


Figure 1. Global DTM (hill-shaded color-coded heights above 2440-km-radius reference sphere) with a lateral spacing of 192 pixel per degree (222 m/pixel) in equidistant projection centered at 0°E (see text).