HIGH-RESOLUTION TOPOGRAPHY FROM MESSENGER ORBITAL STEREO IMAGING – THE H5 QUADRANGLE „HOKUSAI". Alexander Stark [1,2], Frank Preusker [1], Jürgen Oberst [1,2,3], Klaus-Dieter Matz [1], Klaus Gwinner [1], Thomas Roatsch [1]. [1] German Aerospace Center, Institute of Planetary Research, D-12489 Berlin, Germany (Frank.Preusker@dlr.de); [2] Institute of Geodesy and Geoinformation Science, Technische Universität Berlin, D-10623 Berlin, Germany; [3] Moscow State University for Geodesy and Cartography, RU-105064 Moscow, Russia

Introduction: The MErcury Surface, Space ENviorment, GEochemistry, and Ranging (MESSENGER) spacecraft entered orbit about Mercury in March 2011 [1] to carry out a comprehensive topographic mapping of Mercury. Measurement techniques included stereo imaging [2,3], laser altimetry [4,5], limb profiling [6], and radio occultation tracking [7]. We work towards a global high-resolution digital terrain model (DTM) using techniques of stereo photogrammetry [8,9]. While we recently produced and delivered a prototype model for map quadrangle H6 [14], in this paper, we describe the new derived H5 quadrangle "Hokusai" (Fig. 1).

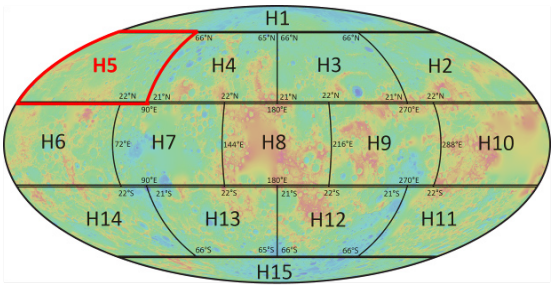

Fig. 1. Mercury's 15 tiles quadrangle scheme. The selected H5 quadrangle is highlighted in red.

Data: The Mercury Dual Imaging System (MDIS) onboard MESSENGER spacecraft consists of a wide-angle camera (WAC) and a narrow-angle camera (NAC) co-aligned on a pivot platform [10]. In almost 4 years MDIS has acquired more than 200,000 images to map the surface. Owing to MESSENGER's highly eccentric near-polar orbit, the WAC is primarily used for the northern hemisphere and the NAC to cover the southern hemisphere, respectively.

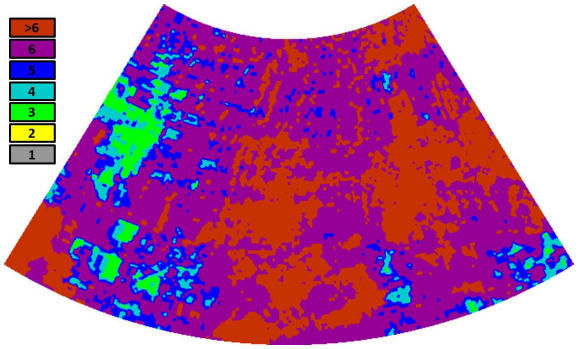

Fig. 2. Stereo coverage of MDIS images having spatial resolutions better than 350 m/pixel. Colors indicate the number of stereo observations.

Those images provide multiple (at least triple) coverage for almost all areas on Mercury at a resolution better than 350 m/pixel.

Stereo Coverage: We have selected about 17,900 images that have resolutions better than 350 m/pixel within the H5 quadrangle area, which extends from 21°N to 66°N and from 0°E to 90.0°E. Subsequently, we applied our stereo conditions [8-9] to compile a stereo coverage map (Fig. 2). From this map we identified about 45,000 stereo image combinations consisting of at least three images each.

Method: The stereo-photogrammetric processing is based on a software suite, which has been developed and applied successfully to several planetary image data sets within the last decade [11-15]. The suite comprises photogrammetric block adjustment, multi-image matching, surface point triangulation, digital terrain model (DTM) generation, and base map production.

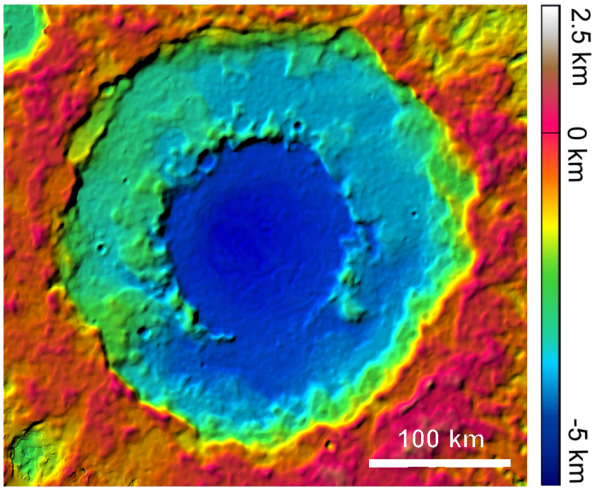

Fig. 3. Topography of the double-ring basin Rachmaninoff wrt. the reference sphere (2439.4 km).

Results: Beginning with nominal navigation (pointing and position) data of the selected stereo images, we have collected ~65,000 tie points for navigation data correction using a photogrammetric block adjustment. This improves the three-dimensional (3D) point accuracy from ±860 m to ±45 m. Then 45,000 individual matching runs were carried out to yield ~4.7 billion object points. The mean ray intersection errors of the ground points were ±50 m. Finally, by interpolation between points, we generated a DTM with a lateral spacing of 192 pixels per degree (~222 m/pixel) and a

vertical accuracy of about 35 m. The H5 DTM covers 6.8% (5.08×10^6 km²) of Mercury's surface and comprises a total height range of 9.5 km (Fig. 5). This model highlights the young Rachmaninoff basin (~310 km diameter) (Fig. 3). Its floor is one of the lowest-elevation areas on Mercury. The comparison of the H5 DTM with data obtained by the Mercury Laser Altimeter (MLA) demonstrates very good agreement of the two data sets (Fig. 4).

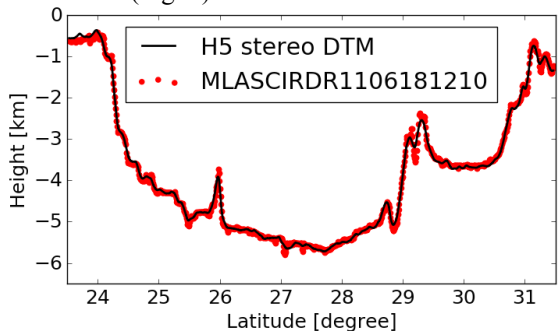

Fig. 4. Comparison of the H5 stereo DTM and MLA profile through the Rachmaninoff basin.

Conclusion: This H5 quadrangle DTM will be delivered in the beginning of March 2017 to the Planetary Data System (PDS). It represents a further element towards a high-resolution global shape model of Mercury from stereo-photogrammetry [14].

References: [1] Solomon S .C. et al. (2011) *EPSC-DPS*, EPSC-DPS2011-430. [2] Oberst J. et al. (2010) *Icarus, 209,* 230–238. [3] Preusker F. et al. (2011) *Planet. Space Sci., 59,* 1910–1917. [4] Zuber, M.T. et al. (2008) *Science, 321*, 77-79. [5] Zuber, M.T. et al. (2012) *Science, 336*, 217-220. [6] Elgner S. et al. (2014) *Planet. Space Sci., 103,* 299-308. [7] Perry M.E. et al. (2011) *Planet. Space Sci., 59,* 1925-1931. [8] Preusker et al. (2017) this issue. [9] Oberst et al. (2017) this issue. [10] Hawkins S.E., III, et al. (2007) *Space Sci. Rev., 131*, 247-338. [11] Gwinner K. et al. (2009) *PE&RS, 75,* 1127–1142. [12] Gwinner K. et al. (2016) *Planet. Space Sci., 103,* 299-308. [13] Preusker F. et al. (2015) *A&A, 583*, A33. [14] Preusker F. et al. (2017), submitted to *Planet. Space Sci.* [15] Scholten F. et al. (2012) *JGR,* 117, E00H17.

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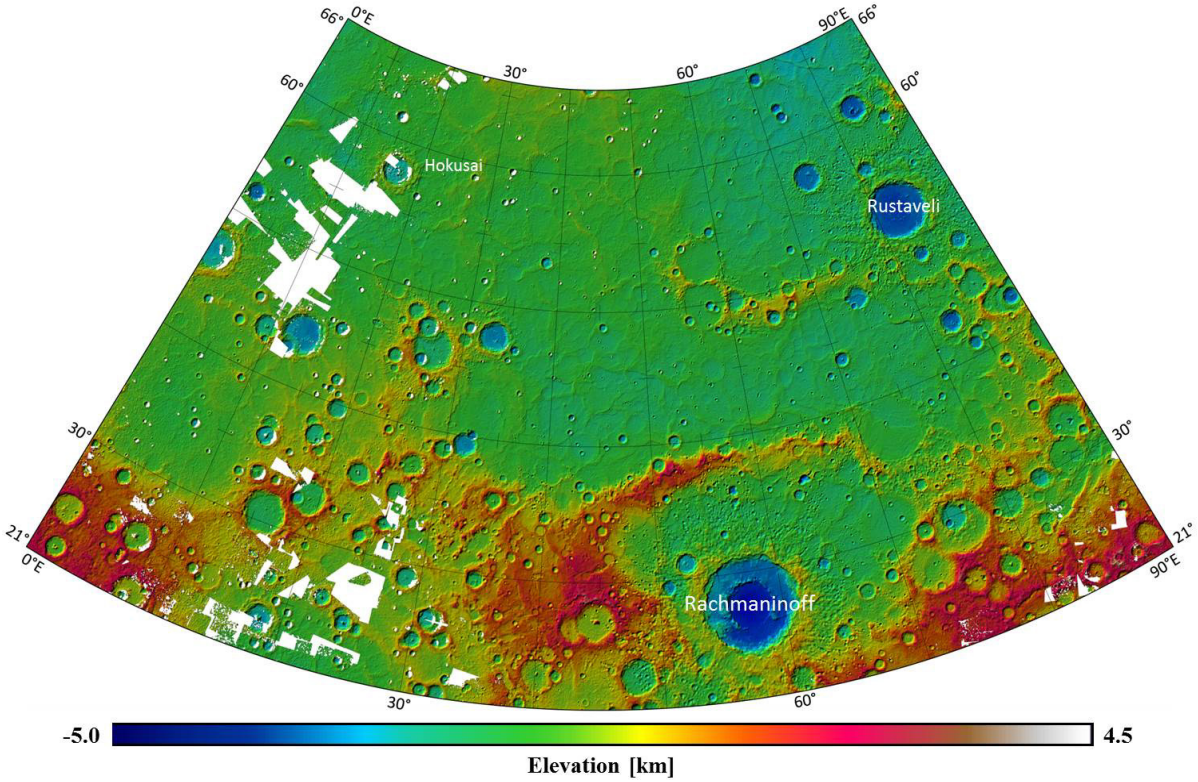

Fig. 5. H5 ("Hokusai") quadrangle DTM (hill-shaded color-coded heights) with a lateral spacing of 192 pixel per degree (~222 m) in Lambert two-parallel (conformal) projection. White areas are gaps in the current processing stage. Completed version of this model will be available at the time of the conference.