MESSENGER IMAGE AND TOPOGRAPHIC MAPS OF MERCURY: PROGRESS AND PROCESS REPORT. M. A. Hunter, T. M. Hare, and R. A. Hayward. Astrogeology Science Center, U.S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, AZ, 86001 (mahunter@usgs.gov).

Introduction: The recent release of global mosaic products generated from MESSENGER MDIS data have facilitated the creation of a new set of Mercury outreach maps to be published by USGS. Based upon the popular lunar map set (SIM 3316, [1]) a new set of 1: 10,000,000-scale global imagery and topographic maps of Mercury is being created, to be submitted for publication in 2017 as a USGS Scientific Investigation Series (SIM) map. This report summarizes the map specifications, methods used thus far, and future work required.

Background: Approved as part of the 2017 NASA-USGS Planetary Spatial Data Infrastructure (PSDI) Inter-Agency Agreement, the imagery map will utilize the 166 meter per pixel (mpp) global image mosaic [2] released by the MESSENGER Team in 2013. The topographic map [3] will use the most recent version of the 665 mpp global digital elevation model created by Kris Becker and the MESSENGER Team (currently at version 2, released October 2016). Both will contain named features approved by the International Astronomical Union (IAU) Nomenclature Working Group for Planetary System Nomenclature (WGPSN) [4]. The layout will include the 1:10,000,000-scale Mercator projection from 55˚ North to 55˚ South, and 1: 6,000,000-scale Polar Stereographic projections of the north and south polar regions above 55˚ North and below 55˚ South, respectively. A minimal amount of nomenclature is being used in the topographic map, and a unique colorized elevation ramp to maximize the readability of the terrain.

Methodology: As with many map publications, the final layout will be composed in Adobe Illustrator, but multiple platforms have been used to optimize each map component. ArcMap is ideal for generating a large amount of nomenclature via feature-linked annotation using a shapefile of nomenclature (the feature boundaries are used to approximate feature areas and not discretely define them) [5]. It also automates the creation of new annotation as new feature nomenclature is approved by the IAU.

For the topographic map a number of different workflows were tested for hillshades, color relief and blending methods. The traditional western illumination was tested at different altitudes using the Geospatial Data Abstraction Library (GDAL) gdaldem method [6], and then compared with the multi-directional hillshade resulting from ArcMap's Image Analyst. While the multi-directional hillshade captures more detail of individual features it was found to be counter-productive to reading terrain at a global scale.

The most subjective, and most prominent, aspect of the map is the color relief scale used; however, a great deal of research has gone into developing a set of options that provide the most readable topographic map. ColorBrewer2 website [7] assisted in identifying complementary colors that are aesthetically balanced and distinctive for people with the most common types of inherited color blindness. These ramps were then recreated in the GIS application Global Mapper and adapted to the global terrain, modifying elevation thresholds and adding more color depth. Once overlaid on the hillshade the multiplier blending method was used to retain full color saturation while bringing forth the hillshade [Figures 1 and 2]. Many other GIS and raster processing platforms were tested, but ultimately Global Mapper provides the most color control for elevation data.

By comparison, the imagery map has used a simple process, but with more time required for feature annotation placement. All named features over 200 km have been included along with smaller, significant features. The imagery map is intended to complement the topographic map by providing detail to facilitate discussion or direction at global and regional scales.

Future Work: Mock-ups of both maps with annotation have been completed, including three color relief options, and work on map text has begun as of this writing. The only changes expected are the additional named features submitted by the MESSENGER Team to IAU WGPSN, which is not expected to delay the publication process. Once the map is finalized and reviewed internally it will be submitted to USGS publication services for finalization and print by the end of the fiscal year.

References: [1] Hare T. M. et al. (2015) *USGS SIM 3316*, https://dx.doi.org/10.3133/sim3316. [2] MESSENGER MDIS Software Interface Specification (SIS) document, (2015), The Johns Hopkins University, APL, V2T. [3] Becker K. J. et al. (2016) *LPSC 47, Abstract 2959*. [4] IAU WGPSN. (2016). *Gazetteer of Planetary Nomenclature*, http://planetarynames.wr. usgs.gov/. [5] Esri (2016) *ArcGIS Help 10.3*, https://desktop.arcgis.com/en/arcmap/10.3/manage-data/annotations/what-is-annotation.htm. [6] GDAL (2016) *Geospatial Data Abstraction Library: Version 2.1.1*, Open Source Geospatial Foundation, http://gdal.osgeo.org. [7] Brewer, C. A. (2016) *ColorBrewer 2.0*, http://www. colorbrewer2.org.

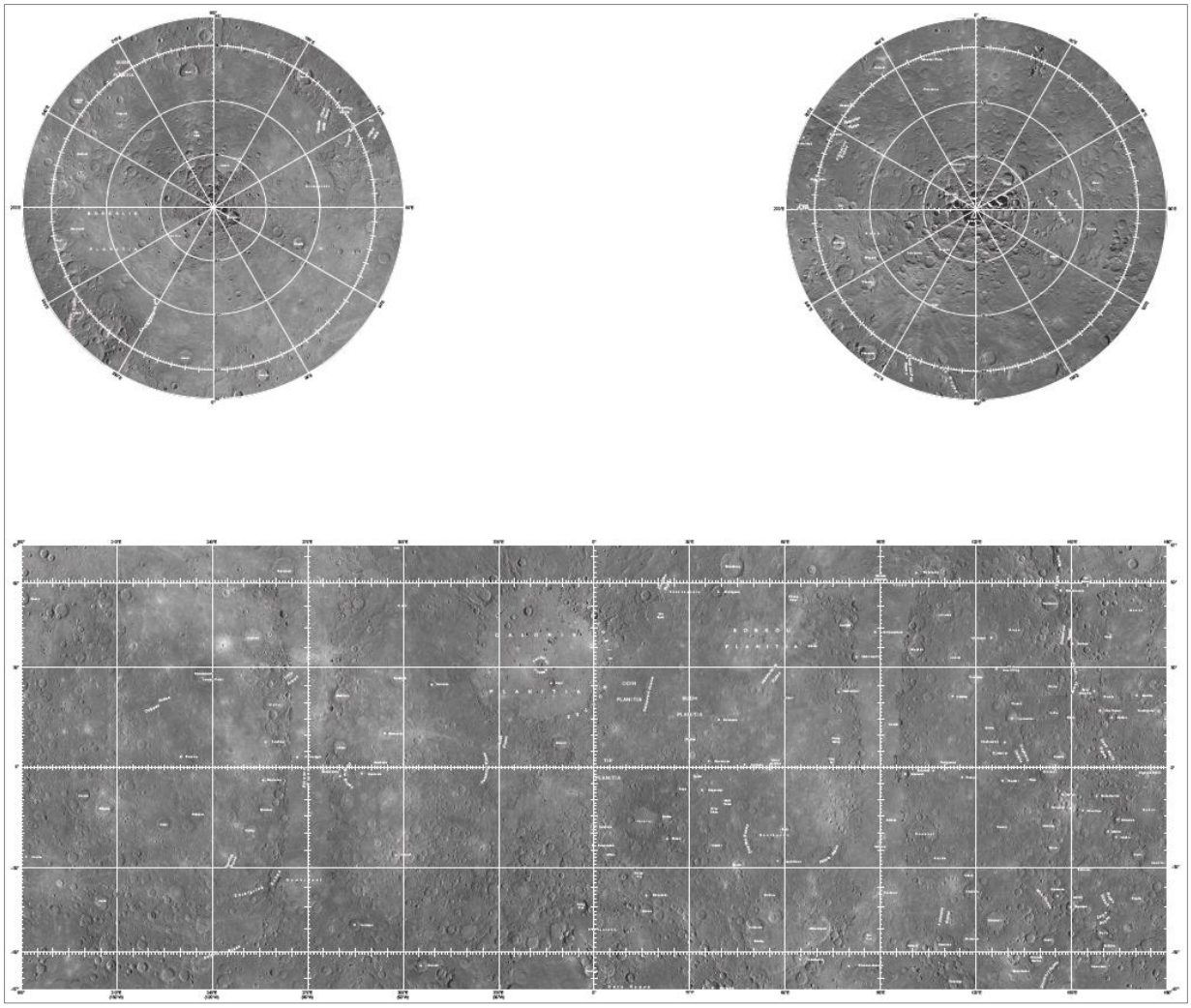

Figure 1. Layout of the preliminary imagery map (without map text or scale bars).

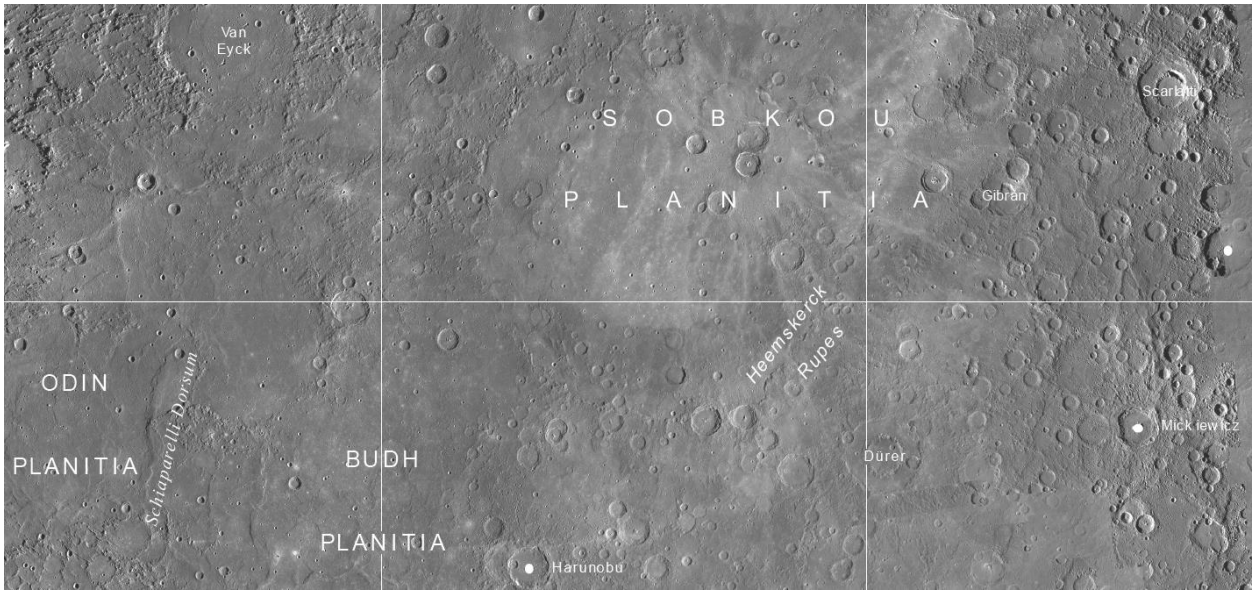

Figure 2. A close-up of the preliminary imagery map showing the placement of named features.