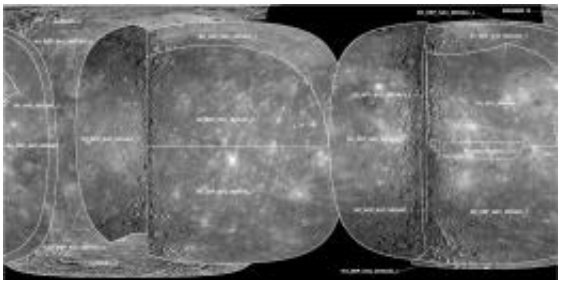
MESSENGER team releases first global map of mercury

December 15 2009



Global map of Mercury showing regions imaged by MESSENGER during three flybys. Each image block is a mosaic of multiple spacecraft images. Black areas indicate no coverage. The final mosaic portrays Mercury's surface in an equirectangular projection at 500 meters/pixel, -180° to +180° positive east longitudes and +90° to -90° planetocentric latitudes centered at 0° longitude and latitude. Because of projection distortion, unimaged regions appear artificially enlarged. Image: Arizona State University

(PhysOrg.com) -- NASA's MESSENGER mission team and cartographic experts from the U. S. Geological Survey have created a critical tool for planning the first orbital observations of the planet Mercury - a global mosaic of the planet that will help scientists pinpoint craters, faults and other features for observation. The map was created from images taken during the MESSENGER spacecraft's three flybys of the planet and those of Mariner 10 in the 1970s. A presentation on the new global mosaic is being given today at the fall meeting of the American Geophysical Union in San Francisco.

The MESSENGER spacecraft completed its third and final flyby of Mercury on Sept. 29, concluding its reconnaissance of the innermost planet. The MESSENGER team has been busily preparing for the yearlong orbital phase of the mission, beginning in March 2011, and the near-global mosaic of Mercury from MESSENGER and Mariner 10 images is key to those plans.

"The production of this global mosaic represents a major milestone for everyone on the MESSENGER imaging team," said MESSENGER principal investigator Sean Solomon of the Carnegie Institution of Washington. "Beyond its extremely important use as a planning tool, this global map signifies that MESSENGER is no longer a flyby mission but instead will soon become an in-depth, nonstop global observatory of the Solar System's innermost planet."

"The process of making a mosaic may seem relatively straightforward - simple software can stitch together panoramas from multiple images. However, the challenging part has been to make cartographically accurate maps from a series of images with varying resolution (from about 100 to 900 meters per pixel) and lighting conditions (from noontime high sun to dawn and dusk) taken from a spacecraft traveling at speeds greater than 2 kilometers per second (2,237 miles per hour)," said Mark Robinson, a professor in the School of Earth and Space Exploration at Arizona State University and a member of the MESSENGER Science Team.

Small uncertainties in camera pointing and changes in image scale can introduce small errors between frames, Robinson said. "And with lots of images, small errors add up and lead to large mismatches between features in the final mosaic. By picking control points - the same features in two or more images - the camera pointing can be adjusted until the image boundaries match." This operation is known as a bundle-block adjustment and requires highly specialized software.

Cartographic experts at the USGS Astrogeology Science Center in Flagstaff, Ariz., picked the control points to solve the bundle-block adjustment to construct the final mosaic using the Integrated Software for Imagers and Spectrometers (ISIS). For the MESSENGER mosaic, 5,301 control points were selected, and each control point on average was found in more than three images (18,834 measurements) from a total of 917 images. Scientists at ASU and the Johns Hopkins University Applied Physics Laboratory (APL) were also instrumental in making the mosaic possible.

"This mosaic represents the best geodetic map of Mercury's surface," said Kris Becker of the USGS. "We want to provide the most accurate map for planning imaging sequences once MESSENGER achieves orbit around Mercury.

"As the systematic mapping of Mercury's surface progresses, we will continually add new images to the control point network, thus refining the map. It has already provided us with a start in the process of naming newly identified features on the surface."

In the final bundle-block adjustment the average error was about two-tenths of a pixel or only about 100 meters - which is an excellent match from image-to-image. The biggest remaining issue is the absolute control of features on the surface. For instance, if the North Pole is not precisely at the spin axis you could have a mosaic in which all the seams overlapped perfectly, but the whole mosaic could slide around like the skin of an orange that somehow became detached from the interior fruit.

Much work was done with the Mariner 10 images collected in 1974 and 1975 to make an absolute control network even though only 45 percent of the planet was seen at the time. The longitude system for Mercury is tied to a small crater named Hun Kal (the number twenty in an ancient Mayan language, because the crater is centered at 20°W). For now,

MESSENGER data are tied to the earlier Mariner 10 control network.

Absolute positional errors in the new mosaic are about two kilometers, according to the MESSENGER team. Once the MESSENGER spacecraft orbits Mercury, much progress will be made refining the relative and absolute control of the MESSENGER (and Mariner 10) images, and the entire planet will be imaged at even higher resolution. The global mosaic is available for download on the USGS Map-a-Planet Web site, www.mapaplanet.org .

Provided by Arizona State University