EPSC Abstracts
Vol. 6, EPSC-DPS2011-273, 2011
EPSC-DPS Joint Meeting 2011

Illumination conditions near Mercury's south pole

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Abstract

The MESSENGER mission is undertaking a dedicated imaging campaign to repeatedly observe the region near Mercury's south pole, with the goal of generating an illumination map. This illumination map will identify areas that are in permanent darkness for comparison with the locations of radar-bright features that have been suggested to host polar ice deposits.

1. Introduction

Earth-based radar observations of Mercury's north and south polar regions have revealed radar-bright features that may coincide with ice deposits in areas of permanent shadow [2]. Until recently, spacecraft images of Mercury's poles were limited to those obtained during two encounters by Mariner 10 in 1974-75, which provided coverage of slightly less than half of Mercury's polar regions. MESSENGER's three Mercury flybys in 2008-2009 were along near-equatorial trajectories and did not image the poles. Using Mariner 10 maps where possible, the radar-bright features were correlated with the interiors of impact craters, providing support for the presence of frozen volatiles in permanently shaded regions near Mercury's poles [2].

On March 18, 2011, the MESSENGER spacecraft became the first to orbit the planet Mercury, entering into a highly elliptical, 12-hr, polar orbit. The science phase of the mission began on April 4, 2011, and is planned to continue for one Earth year. During the primary mission, MESSENGER's Mercury Dual Imaging System (MDIS) [3] will acquire >75,000 images in support of the mission's overall science goals. One of MDIS's imaging campaigns is devoted to repeatedly observing Mercury's south polar region, to identify areas of permanent shadow for comparison with the radar data. Here we present the first results from MDIS's south polar monitoring campaign.

2. South Polar Imaging Campaign

MDIS's south polar imaging campaign is divided into two phases. During the first Mercury solar day (176 Earth days) of the mission, MDIS's wide-angle camera (WAC) is imaging Mercury's south polar region on every fourth orbit, corresponding to every other Earth day, or just over every 1% of a Mercury solar day. A total of 88 WAC images are planned; the first was acquired on April 6, 2011, and the last is planned for September 26, 2011. The region south of 70°S is being imaged repeatedly at 1.5 km/pixel, and the combined illumination conditions provide coverage that spans a 180° range of solar azimuths for conditions when the solar incidence angle is <90° (the surface is sunlit), as shown in Fig. 1. Figure 2 shows three of the south polar campaign images. On the mission's second Mercury solar day, MDIS's narrow-angle camera (NAC) will repeatedly image the region south of 85°S at a resolution of 300 m/pixel, providing higher-resolution information about the locations nearest to Mercury's south pole.

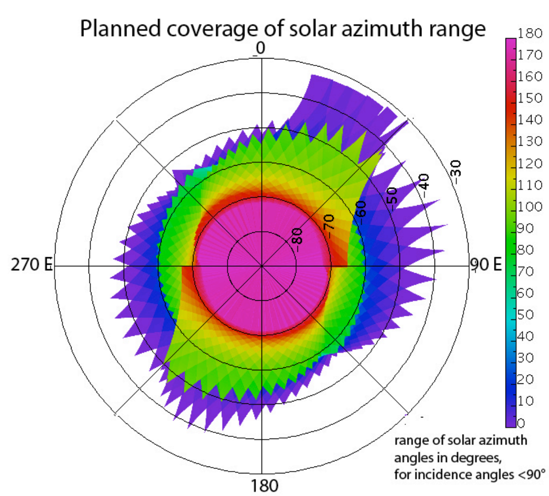

Figure 1: MDIS's planned coverage of solar azimuth range at the south pole over the first Mercury solar day of the mission.

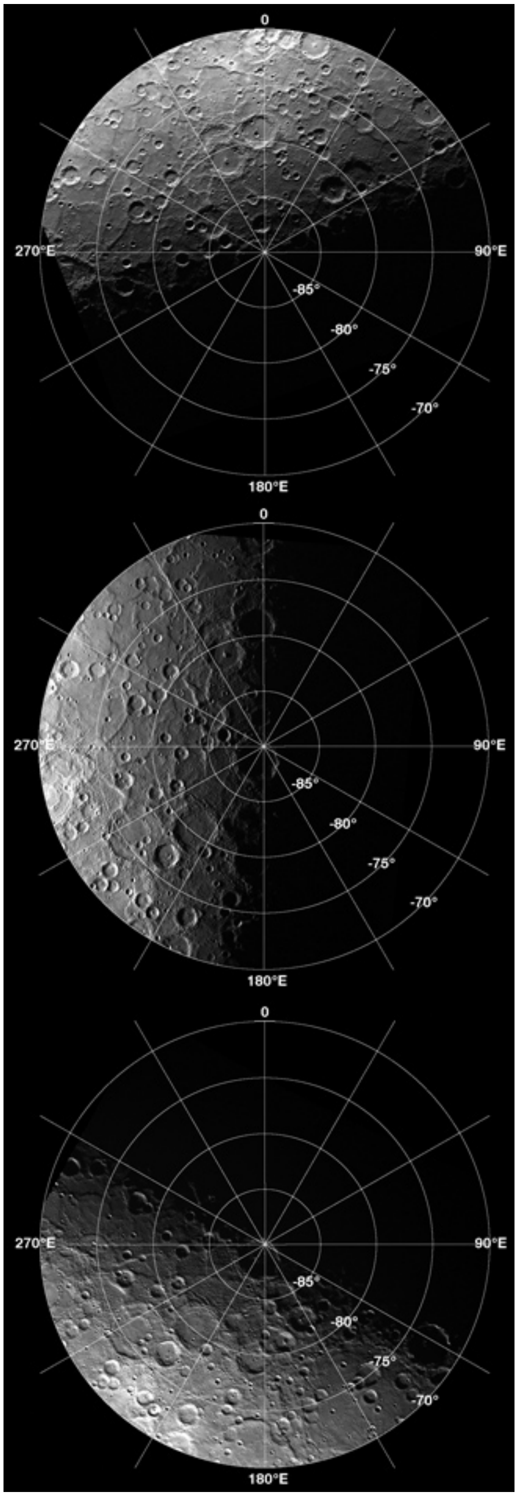

Figure 2: Three example images from MDIS's south polar monitoring campaign. *Top:* Image ID #95934, April 6, 2011. *Middle:* Image ID #185980, April 28, 2011. *Bottom:* Image ID #267891, May 18, 2011.

3. Analysis Approach

The repeated imaging of Mercury's south polar region enables an illumination map to be generated, such as has been done for the lunar poles [1]. To generate the illumination map, a threshold is applied to each image, separating the surface into sunlit and shadowed areas. After thresholding, the images from one Mercury solar day are averaged together, to produce a map of the percentage of time that a given area of surface is illuminated. Radar-bright features near Mercury's south pole will be compared with the resulting illumination map, and it will be determined if such features always correlate with areas of permanent darkness. Additionally, the fraction of permanently shadowed regions that contain radar-bright material will be determined, and craters with permanent darkness will be cataloged and characterized. Preliminary work has demonstrated the feasibility of this analysis approach. By October 2011, results from an entire Mercury solar day will be available.

Acknowledgements

We thank T. H. Choo for implementing MDIS's south polar monitoring campaign; N. R. Laslo and S. E. Hawkins, III, for performing current MDIS orbital operations; and the devoted efforts of numerous individuals over the past decade who have made the MESSENGER mission possible.

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