CRATERS HOSTING RADAR-BRIGHT DEPOSITS IN MERCURY'S NORTH POLAR REGION. Nancy L. Chabot[1], Carolyn M. Ernst[1], John K. Harmon[2], Scott L. Murchie[1], Sean C. Solomon[3], David T. Blewett[1], Brett W. Denevi[1], [1]Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Rd., Laurel, MD, 20723, USA, Nancy.Chabot@JHUAPL.edu, [2]National Astronomy and Ionosphere Center, Arecibo Observatory, HC3 Box 53995, Arecibo, PR, 00612, USA, [3]Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, DC, 20015, USA.

Introduction: About two decades ago, Earth-based radar observations led to the discovery of radar-bright features near Mercury's poles that were hypothesized to be water ice trapped in cold, permanently shadowed locations [1, 2]. Subsequent observations resolved numerous radar-bright features scattered near both poles. However, many radar-bright features could not be mapped to craters or other geologic features as space-

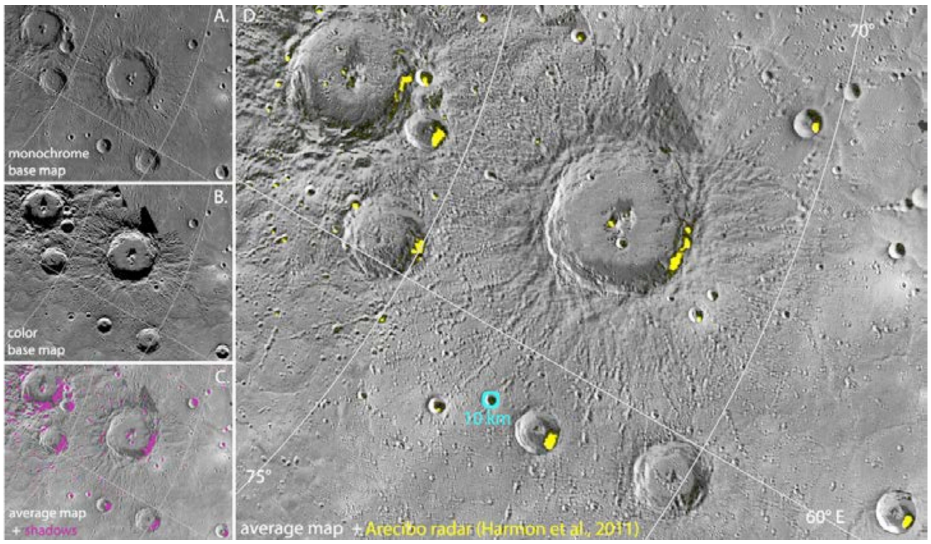
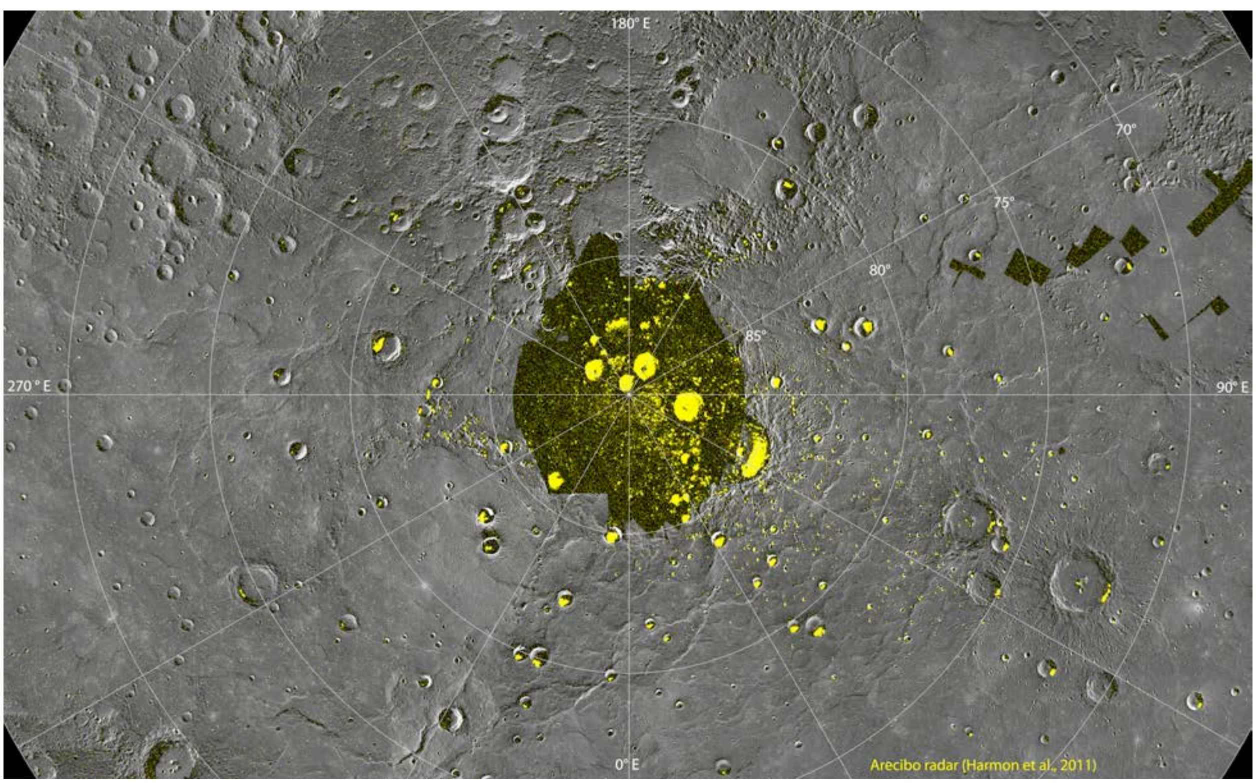


Figure 1. (Left) (A) Monochrome and (B) color base maps show the same terrain under different illumination conditions. (C) An average of the two base maps yields areas in shadow in both (pink), and (D) radar-bright features (yellow) show agreement with shadowed locations.

Figure 2. (Bottom) Mercury north polar radar-bright features (yellow) compared with MDIS monochrome base map.



craft images of the polar regions were limited to those obtained during Mariner 10 flybys. In March 2011, MESSENGER became the first spacecraft to orbit Mercury and began to return data for the entire planet.

One of the early campaigns of the Mercury Dual Imaging System (MDIS) [3] was to image the south polar region repeatedly. Results of that campaign indicate that all radar-bright features near Mercury's south pole are located in areas of permanent shadow [4]. MESSENGER's highly eccentric orbit (minimum altitude is ~200 km in the north and maximum altitude is ~15,200 km in the south) does not allow a similar imaging campaign for Mercury's north polar region. However, the lower altitude permits surface measurements not only by MDIS but also by the Mercury Laser Altimeter (MLA) and Neutron Spectrometer (NS) that are not possible in the south, enabling a multi-instrument investigation of the nature of the radar-bright materials at Mercury's north pole. Here we present MDIS results related to that investigation.

Method and Results: MDIS imaging to date provides near global coverage of Mercury's surface up to ~85°N at ~250 m/pixel. Two independent global base maps have been acquired, one optimized for determining surface morphology and the other for color characteristics. The two base maps provide two different illumination conditions for examining the north polar region (Figs. 1A, 1B). Averaging the two base maps shows the locations that remain shadowed in both views (Fig. 1C), for comparison to the highest-resolution Earth-based radar images [5] (Fig. 1D).

All radar-bright features are associated with locations shadowed in both MDIS base maps within the registration limits (Fig. 2). Of particular note are many lower-latitude radar-bright features, extending to ~67°N, that map to shadowed regions inside craters of varying sizes (Figs. 1D, 2). Thermal modeling work indicates that a thin insulating layer of regolith is required for water ice to be stable in shadowed craters ≤40 km in diameter when located equatorward of ~82° [6]; many such craters that host radar-bright features are identified at Mercury's north polar region.

Mapping of all craters with diameters ≥10 km (Fig. 3A) shows that craters hosting radar-bright features near Mercury's north pole are prevalent, while those lacking radar-bright features are the exceptions. In particular, nearly all craters located near the "cold pole" of 90°E have associated radar-bright features. Further work to take into account limitations due to the radar viewing conditions is needed before concluding whether all of the available cold traps are filled.

Many smaller craters also host radar-bright deposits, such as the field of secondaries shown in Fig. 3B. Thermal modeling predicts that water ice is not stable in craters ≤10 km in diameter located more than 2° from Mercury's pole even with a thin layer of regolith insulation [6]. If these smaller craters differ from the idealized bowl-shaped model, such as being shallower or rougher, then perhaps the thermal environment could be favorable for water ice; such craters are important subjects for future thermal modeling.

Conclusions: All radar-bright features near Mercury's north pole are confined to shadowed areas in MDIS images to date, consistent with the water-ice hypothesis. A thin layer of insulation is required for the radar-bright material in many larger craters to be water ice. Low-latitude (<75°) and small (<10 km in diameter) craters that host radar-bright deposits provide challenging thermal environments for water ice, an issue that should be addressed with future thermal models.

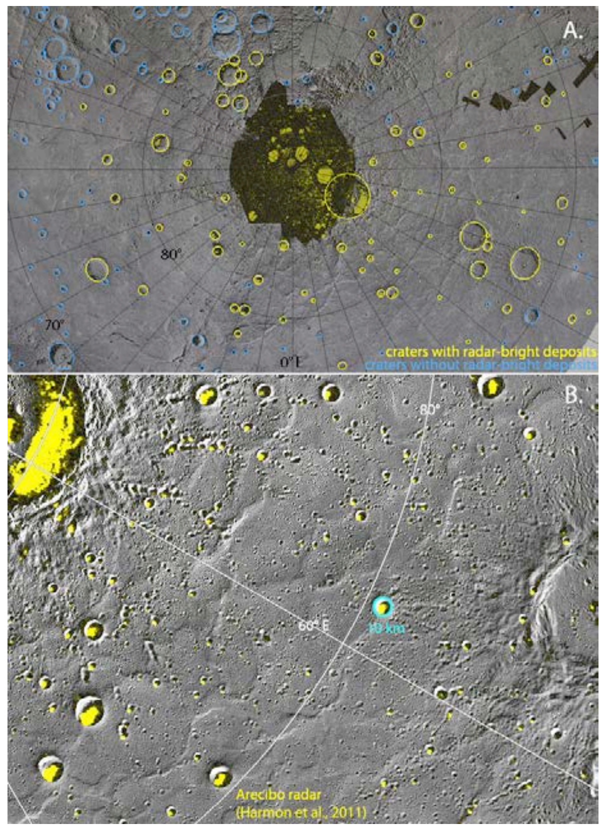


Figure 3. (A) Map of all craters >10 km in diameter. (B) A portion of (A) showing that many small craters (<10 km in diameter) are associated with radar-bright features (yellow).

References: [1] Slade M. A. et al. (1982) *Science* 258, 635-640. [2] Harmon J. K. and Slade M. A. (1992) *Science* 258, 640-643. [3] Hawkins S. E. III et al. (2007) *Space Sci. Rev.* 131, 247-338. [4] Chabot N. L. et al. (2011) *EPSC-DPS2011-273*. [5] Harmon J. K. et al, (2011) *Icarus* 211, 37-50. [6] Vasavada A, R, et al. (1999) *Icarus* 141, 179-193.