FINAL CALIBRATION AND MULTISPECTRAL MAP PRODUCTS FROM THE MERCURY DUAL IMAGING SYSTEM WIDE-ANGLE CAMERA ON MESSENGER. Brett W. Denevi[1], Frank P. Seelos[1], Carolyn M. Ernst[1], Mary R. Keller[1], Nancy L. Chabot[1], Scott L. Murchie[1], Deborah L. Domingue[2], Christopher D. Hash[3], and David T. Blewett[1], [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA. [2]Applied Coherent Technology Corporation, Herndon, VA 20170, USA. [3]Planetary Science Institute, Tucson, AZ 85719, USA.

Introduction: Multispectral imaging was one of the main mapping priorities of the MESSENGER mission's ~four years in orbit about Mercury [1]. Color imaging was achieved with MESSENGER's wide-angle camera (WAC), one of two cameras that comprised the Mercury Dual Imaging System (MDIS) [2]. The WAC had a 10.5° field of view and acquired images through 11 narrow-band filters (430–1020 nm) and a clear filter (used mainly for imaging stars and permanently shadowed regions). An initial in-flight calibration was performed during cruise [3], but during orbit it was recognized that filter-dependent changes in responsivity on the order of ±15% occurred over timescales as short as several days. Because those variations were not consistent from filter to filter, they led to spurious spectral features, which were particularly conspicuous near 750 nm. The cause(s) of these variations in responsivity are not presently known, but they could include transient radiation effects on the detector or electronics, aging of filters, periodic deposition and burn-off of contaminants on filters, or incorrect recording of exposure time. An initial empirical correction for images acquired in the first year of operations was developed [4]. Here we report on a correction developed that spans the full duration of MESSENGER's orbital operations and will be applied to individual WAC images and final multispectral mosaics delivered to the Planetary Data System (PDS) imaging node in May 2016.

Derivation of empirical calibration: Because no consistent time-varying trends in responsivity were found, we used image overlap to derive a multiplicative correction factor for each filter and for each Earth day (2–3 orbits). We selected all image data with a pixel scale >50 m and incidence angle (measured at the center pixel) <80°. The images were calibrated to reflectance using the standard calibration, but with recent updates to the temperature dependence of charge-coupled device responsivity, the readout timing used to correct for frame-transfer smear, and newly derived flat-field corrections. Images were then photometrically normalized [5], trimmed to exclude any portions of the scene with incidence angles >70° or emission angles >30°, and mapped to an equal-area (sinusoidal) projection at 4 km/pixel. All images acquired on each day were mosaicked for each filter, typically resulting in a fairly narrow north–south strip that had substantial overlap with surrounding days.

With this dataset, multiplicative correction factors for each day were calculated through a weighted least-squares optimization that minimized the discrepancy between the median values for all spatial overlaps. The

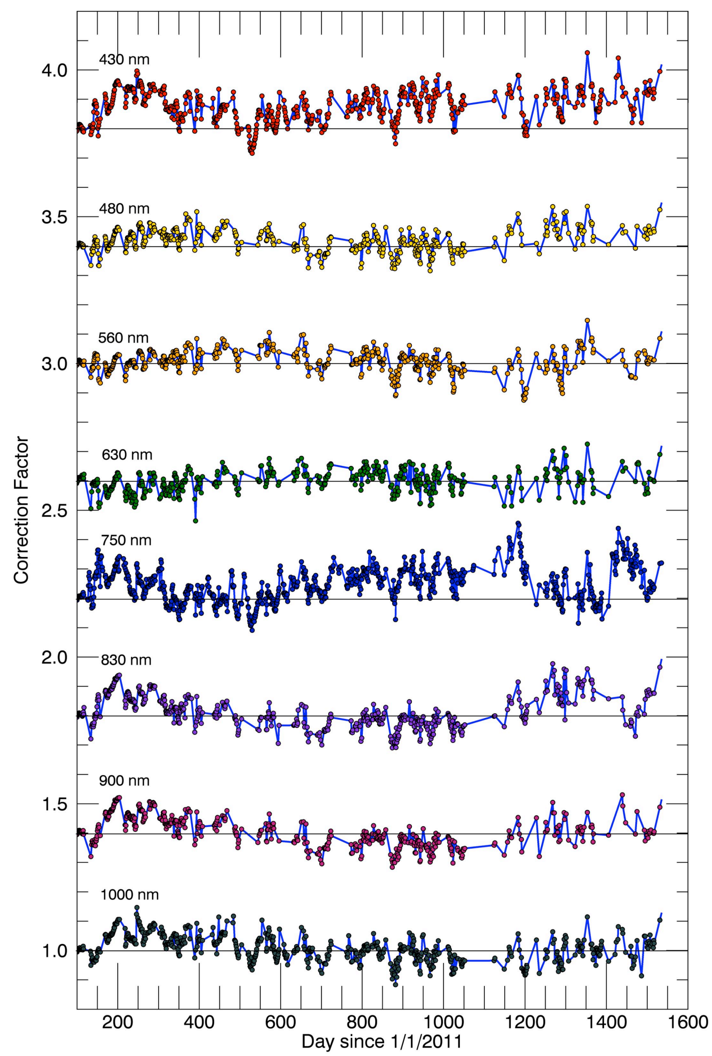

Fig. 1. Multiplicative correction factors derived for WAC filters; each is offset by 0.4 for clarity. Points are correction factors derived from image data; blue lines show segments interpolated from surrounding days.

optimization was performed in two steps. First, a mosaic of data acquired before 22 May 2011 was held as constant, because this dataset was seen to be largely self-consistent. However, these data covered only a fraction of the planet, so a mosaic with greater coverage was created from images that were corrected in the first iteration with low residual values. In the second step, all data were allowed to vary in the simultaneous optimization, with the new mosaic held as reference. The resulting multiplicative correction factors are shown in Fig. 1. Correction factors were derived for days on which no data were included in our optimization process by interpolating between adjacent days. Filters with center wavelengths at 700, 950, and 1020 nm were not used for regional or global mapping and thus did not have enough overlap to derive correction factors with this method. Instead, the empirical correction was derived by comparing them with a synthetic global mosaic created by linear interpolation from images acquired with adjacent filters.

Results: The final calibrated data records (CDRs) will be delivered to the PDS both with and without the empirical correction. Final three-, five-, and eight-color mosaics [1] were created using the updated correction, and an analysis of overlap among individual images shows that residual differences (which include errors from calibration, scattered light, and possible incomplete correction of photometric variation) average <2% for the majority of the planet.

References: [1] Chabot N.L. et al. (2016) *LPS,* this meeting. [2] Hawkins III S.E. et al. (2007) *Space Sci. Rev.*, *131*, 247–338. [3] Hawkins III S.E. et al. (2009) *Proc SPIE*, *7441*. [4] Keller M.R. et al. (2013) *LPS, 44*, 2489. [5] Domingue D.L. et al. (2016) *Icarus*, doi:10.1016/j.icarus.2015.11.040, in press.

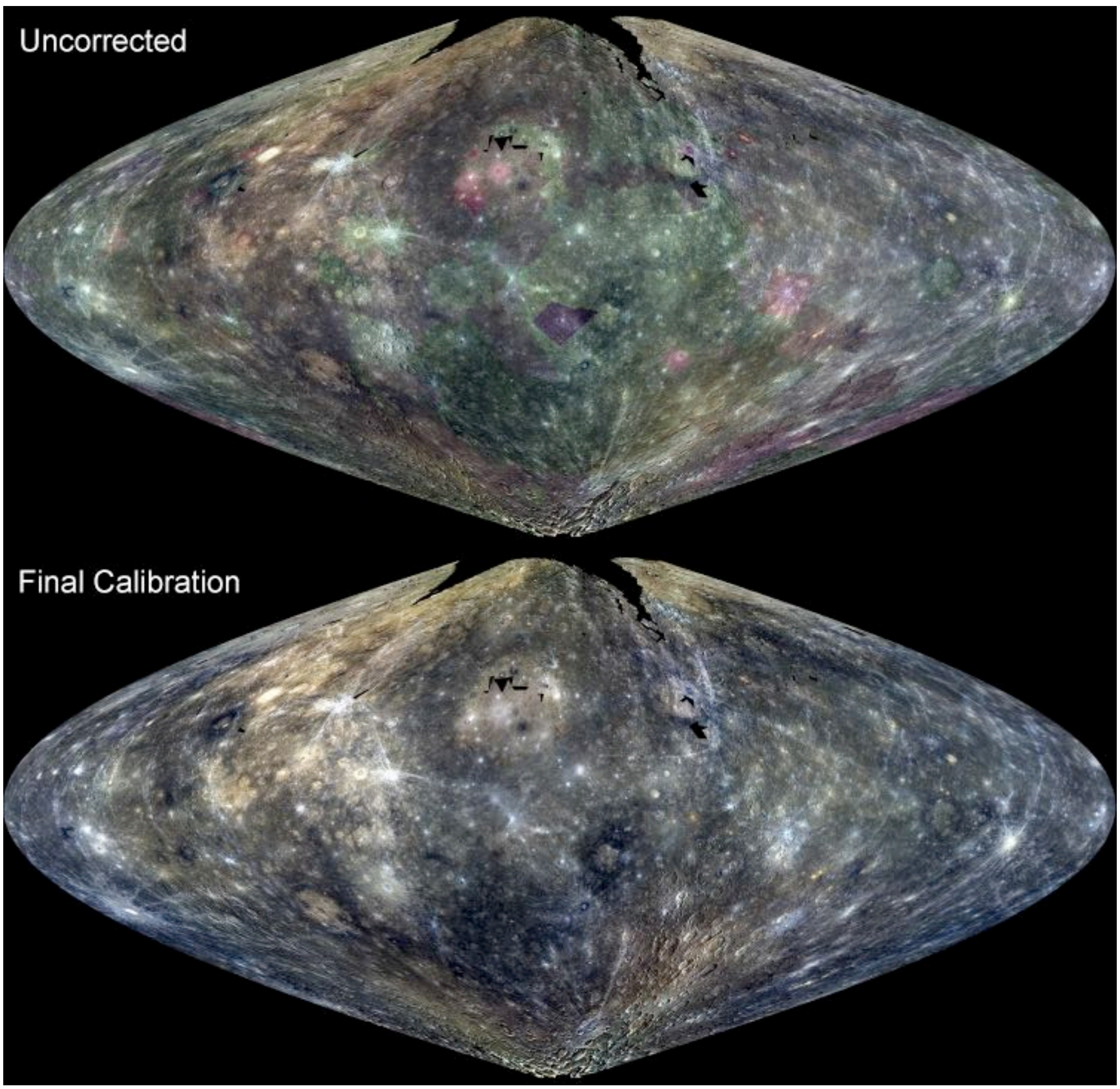

Fig. 2. MDIS 8-color mosaic. Top: with no correction for time-varying responsivity. Bottom: after application of the empirical correction factors shown in Fig. 1. Sinusoidal projection centered at 180° E. The same stretch is applied to both mosaics.