THE STATUS OF RESTORATION OF MOON MINERALOGY MAPPER DATA.

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Introduction. An important dataset for the mapping and characterization of lunar surface resources was acquired by the NASA Moon Mineralogy Mapper (M^3) instrument [1-4]. Our work continues on geospatial restoration of the M^3 data, improving the geodetic control of these hyperspectral data covering >95% of the Moon. Using Global and Targeted imaging modes (at 140 and 70 m/pixel spatial resolution, respectively) with spectral resolution of 20-40 nm in 85 channels between 460 and 3000 nm, the M^3 data are uniquely valuable for characterizing surficial water [2, 5], soil and rock mineralogy [6-9], and water in lunar pyroclastic deposits [10]. Our goal is to use the high spatial resolution (~100 m/pixel) and improved horizontal geodetic accuracy of the Lunar Reconnaissance Orbiter Wide Angle Camera (WAC) stereo-derived topographic model [i.e., the GLD100 digital terrain model or DTM, 11] to improve the positional accuracy of M^3 frames tied to the 3D lunar surface.

This project has 7 goals: (1) Reprocess M^3 data with the mission's Level 1B (L1B) processing pipeline and the GLD100 to improve selenolocation accuracy; (2) Develop USGS Integrated Software for Imagers and Spectrometers (ISIS3) software to ingest and process M^3 data [12, https://isis.astrogeology.usgs.gov/]; (3) Control the global M^3 dataset with better geodetic accuracy and update L1B products; (4) Reprocess improved L1B data through the mission's Level 2 (L2) pipeline to improve thermal and photometric accuracy; (5) Update the photometric modeling; (6) Create orthorectified frame and mosaicked (Level 3) data products; and (7) Deliver interim and final products, including NAIF SPICE kernels [13] and restored M^3 frames to the Planetary Data System (PDS). Goals 1 to 3 are completed, and work on 4 to 7 is underway.

Improved Geodetic Control. The M^3 L1B IDL pipeline was used to reprocess the data through ray tracing and geometric modeling, creating a full-mission orthorectified product. The improvement of geodetic control of M^3 frames makes use of ISIS3 software [12], which allowed us to model rigorously the physics and geometry of image formation by the M^3 camera. We used the M^3 camera model in ISIS3, added tie points to the lunar surface with automated and manual procedures, and bundle-adjusted the frames [13]. To develop a control solution for the M^3 data, we orthorectified the images and evaluated the positional consistency of overlapping images in map coordinates. The final M^3 control network is based on 859 images, 102,547 points (including 39,024 constrained points), and 379,412 measurements. The largest offsets (up to ~5 km) from original image placements were observed in M^3 data from Optical Period OP2C.

Photometric Correction: The Level 2 [L2] pipeline has been updated for newer hardware and is being used to compute normalized reflectances from the Level 1B radiances and improved LOC and OBS files [14]. The initial Lommel-Seeliger photometric correction was updated for the improved M^3 data and correction coefficients for each wavelength are being applied to thermally corrected [15] L2 data.

Our major products are improved hyperspectral frames (including all M^3 Global and Target Mode data, L1B and L2) closely tied to the 3D lunar surface, along with updated kernels and metadata. Late in 2017, we will deliver these products to PDS and make them publicly available. These data will be important for new research on lunar resources, mapping of volatiles, surface compositions, etc.

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