COMPARISONS OF DATA REDUCTION METHODS FOR IMPACT PLUME DETECTION IN LCROSS TIME SERIES OBSERVATIONS FROM MRO. Ruth L. Temme[1], Paul D. Strycker[1], Nancy J. Chanover[2], Ryan T. Hamilton[3], Charles Miller[2], [1]Concordia University Wisconsin, Mequon, WI, USA, [2]New Mexico State University, Las Cruces, NM, USA, [3]SOFIA-USRA, NASA Ames Research Center, Moffet Field, CA, USA.

Introduction: The Lunar Crater Observation and Sensing Satellite (LCROSS) mission was designed to eject regolith from Cabeus crater in order to be observable from space assets and ground-based telescopes [1, 2]. One main mission goal was analysis of particle velocities and angles in the ejecta, for which ground-based data were essential. However, the plume was not bright enough to be seen in ground-based imaging, so further data reduction was required to detect evidence of the plume. In the case of images taken from Apache Point Observatory (APO) with a high-speed imager, a plume signal was detected after principal component analysis (PCA) filtering [3]. In this work, we apply PCA filtering to data acquired at Magdalena Ridge Observatory (MRO) with the goal of improving the signal-to-noise ratio of the ejecta plume and of corroborating APO results with data that featured a higher time resolution. Here we compare different data reduction methods for MRO and discuss the resulting plume brightness curves.

Data and Data Reduction: The 2.4-m telescope at MRO was equipped with two high-speed frame transfer CCD cameras, GJON and DOC, to observe the impact ejecta. An ultraviolet bandpass (U) filter was placed prior to a beam splitter, and GJON imaged the blue channel while DOC imaged the red channel. The exposure time used for both cameras for all LCROSS campaign images was 0.032 seconds, and the interval between frames was 0.034 seconds. The total time series acquired by each camera amounted to nearly 13,000 frames from -58.472 to 383.460 seconds relative to impact.

We reduced the GJON and DOC data separately. For each time series, we used a Fast Fourier transform (FFT) to identify the image with the highest spatial frequencies. This image was then apodized with Cabeus crater at the center to produce a first reference image for co-registering that time series. We conducted a PCA on the co-registered data, and used principal components (PCs) describing the landscape (PC1) and variable atmospheric seeing (PC2) to reconstruct the best image in the time series with minimal spatial distortions and shot noise, which are present in the unused, higher-order PCs. We apodized this new reference image of Cabeus crater and co-registered the original, unregistered time series a second time. We present this new method of using PCA to obtain reference images because the MRO data suffer from spatial distortions at least an order of magnitude greater than the APO data.

Comparisons of Methodology: Here we compare multiple methods for data selection, PCA filtering, and binning. Our three choices of data selection include (1) using all the frames, (2) using only the clearest frames as determined by FFT (lucky imaging), and (3) using the least distorted frames as determined by PCA. We explore the effects of subtracting PCs to filter out variable seeing, spatial distortions, and shot noise. Finally, we investigate the trade-off between spatial and temporal resolution and signal-to-noise ratio. We present a comparison of the brightness curves that result from various combinations of these methods.

This work was supported by NASA's Lunar Data Analysis Program through grant number NNX15AP92G.

References: [1] Colaprete, A. *et al.* (2010) *Science*, *330*, 463–468. [2] Schultz, P. H. *et al.* (2010) *Science*, *330*, 468–472. [3] Strycker, P. D. *et al.* (2013) *Nat. Commun.*, *4:2620*, doi:10.1038/ncomms3620.