LUNAR RECONNAISSANCE ORBITER CAMERA GLOBAL MORPHOLOGICAL MAP OF THE MOON. E. J. Speyerer[1], M. S. Robinson[1], B. W. Denevi[2], and the LROC Science Team, [1]School of Earth and Space Exploration, Arizona State University, Tempe, AZ, [2]Johns Hopkins University Applied Physics Laboratory, Laurel, MD.

Introduction: The Lunar Reconnaissance Orbiter Camera (LROC) Wide Angle Camera (WAC) provides global imaging of the Moon at a scale of 100 m/pixel. The WAC is a push-frame camera that captures seven color bands (321, 360, 415, 566, 604, 643, and 689 nm) with 57-km swath and a 105-km swath in monochrome mode from a 50 km orbit [1]. Each month, the WAC provides near complete coverage of the Moon. These images are mosaicked to create global maps under different lighting conditions. One of the primary objectives of LROC is to provide a global 100 m/pixel monochrome basemap with incidence angles between 55°-75°, favorable for morphological interpretations.

WAC Calibration: Before the launch of the Lunar Reconnaissance Orbiter (LRO), the LROC instruments underwent a comprehensive ground calibration sequence to measure instrumental response to known, calibrated inputs [1]. The calibration efforts have continued since launch to ensure an accurate dataset for current and future science and exploration investigations, including updates to camera pointing, geometric calibration, dark imaging, flat-field imaging, and photometry.

Camera pointing. The location of each Apollo landing site and two Soviet landers has been precisely pinpointed with the aid of the laser ranging retro-reflectors and very long baseline interferometry [2,3]. Since these spacecraft are not visible at the WAC's 100 m/pixel scale, the WAC is geometrically calibrated to Narrow Angle Camera (NAC) images. The NAC's 0.5 m/pixel imaging enables the identification of the landing sites, and thus allows accurate pointing to be determined. Through sub-pixel registration between pairs of map projected WAC and NAC images (acquired simultaneously), corrections are made to the position of the WAC frame in order to align it to the NAC image. By noting the shift between the image pairs, adjustments are made to the three angles that define the pointing of the WAC.

Geometric calibration. During preflight calibration, functions were derived to correct for the distortion though the wide angle lens:

$$x_d = x_c \cdot \left(1 + k_1 r^2 + k_2 r^3\right)$$

$$y_d = y_c \cdot \left(1 + k_1 r^2 + k_2 r^3\right)$$

where x_d and y_d are the distorted pixel positions, x_c and y_c are the corrected pixel positions, r is the radius from the optical center, and k_1 and k_2 are the distortion coefficients [1]. Using a similar coregistration technique, adjustments were made to the distortion coefficients, optical center, and focal length. WAC images were coregistered to NAC frames acquired at different times, but under similar lighting conditions. The coordinates of each control point were then remapped back into camera space. By treating the NAC frames as truth, x_c and y_c were defined. By comparing those estimates to the original WAC pixels, x_d and y_d, modifications were made to the distortion parameters to reduce the geometric distortion in the map projected WAC frames.

Dark imaging. In addition to adjustments to the camera geometry, detector characterization has also improved since launch. While on the night side of the Moon, LROC collects images to characterize the electronic bias in the instrument. Dark frames are acquired at each bias level and a broad range in temperatures. This enables averaged dark files to be produced for each bias level and in 1° C temperature bins to improve the correction to about 1 digital number.

Flat-field imaging. New flat-field images were produced from inflight images to characterize the non-uniformity responsivity on a pixel-by-pixel basis. Images were collected after a 90° yaw of the spacecraft to ensure that for each line, every sample of the push-frame imager observed the same terrain. The observation was dark-corrected with a night-side image acquired close in time and at a comparable temperature, and photometrically corrected using a preliminary WAC-derived function [4]. Averaging each frame in the observation produced the final flat-field frames.

Photometry. For the monochrome global mosaic, the images were photometrically corrected to standard viewing and illumination conditions using a Hapke photometric model [5] that employs a double-lobed Henyey-Greenstein single particle scattering function.

Mosaic Release: This spring, the LROC science team will be releasing a monochrome (643 nm) global morphological basemap (Figure 1) through the LROC website (http://lroc.sese.asu.edu) and the PDS. The basemap will reflect the latest calibration and the 100 m/pixel digital terrain model (DTM) derived from the WAC images [6], except at the poles where a LOLA DTM will be substituted.

References: [1] Robinson et al. (2010) *Space Sci. Rev.*, 150, 81-124. [2] Merton et al. (2000) *JGR* 105, 20277-20280 [3] Murphy et al. (2010) arXiv:1009.5720v2 [4] Sato et al this volume. [5] Hapke (1993) *Theory of Reflectance and Emittance Spectroscopy*, Cambridge University Press. [6] Scholten et al this volume.

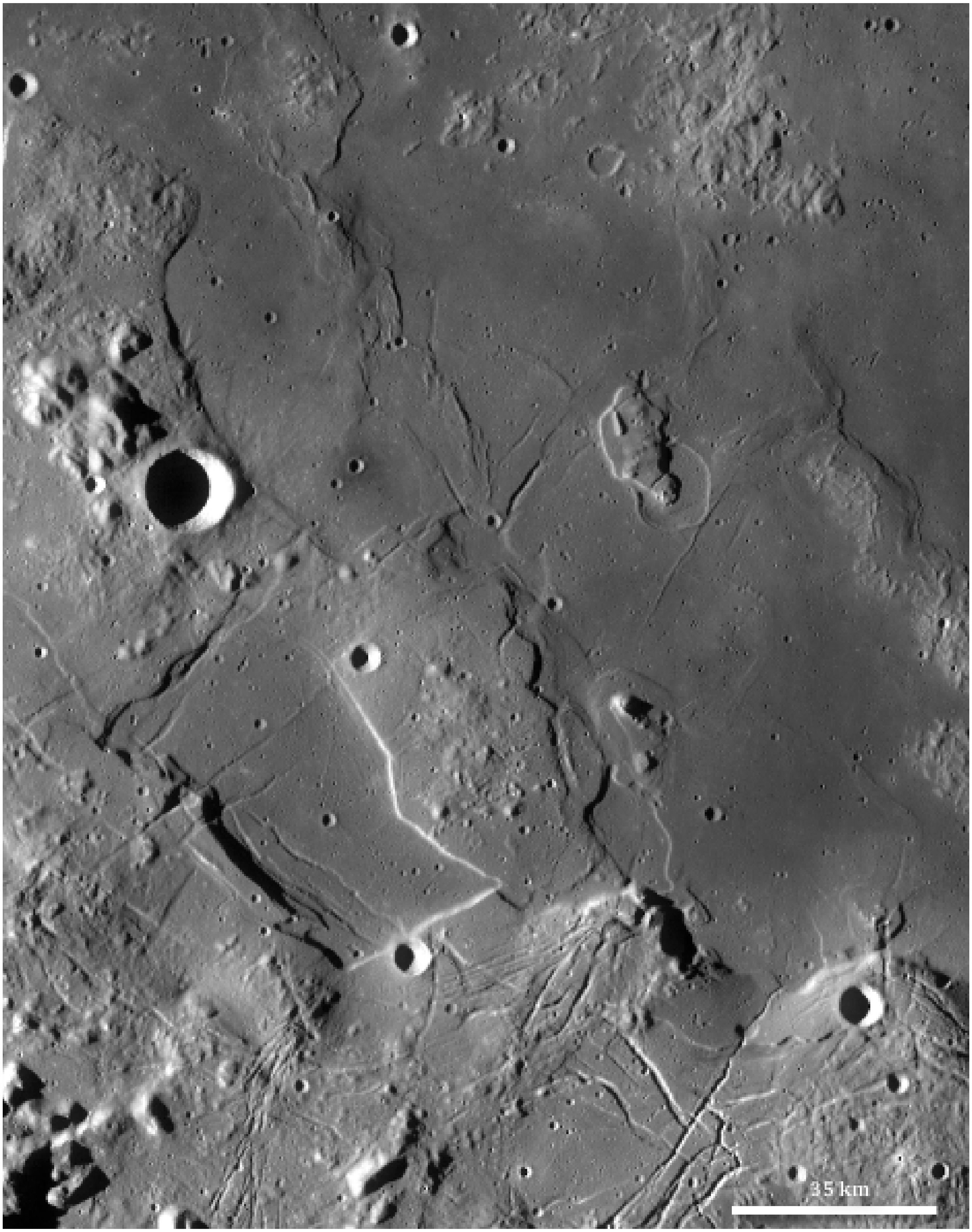

Figure 1- Full-resolution region of the LROC morphologic basemap, southwest corner of Orientale basin [NASA/GSFC/Arizona State University].