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ABSTRACT SUBMISSION FORM

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Title of the Paper Radargrammetric mapping of the Moon with Mini-RF	
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ABSTRACT(more than 300 words) [5]

NASA's Mini-RF investigation consisted of two synthetic aperture radar (SAR) instruments designed to image the Moon, particularly the permanently shadowed areas near the poles that have been postulated to contain water ice deposits: Mini-SAR or "Forerunner" on the ISRO Chandrayaan-1 orbiter (CH1, operating 11/2008-8/2009), and Mini-RF on the NASA Lunar Reconnaissance Orbiter (LRO, radar operating 6/2009-12/2010). Both instruments were capable of "baseline" imaging with 150-m resolution (75 m/pixel) in S band (12.6 cm λ). The LRO radar added X band (4.2 cm λ) capability and a 7.5 m/pixel "zoom" mode at both wavelengths. The legacy of these missions includes essentially complete coverage of both lunar poles in S-baseline and S-zoom modes, near-complete X-baseline polar coverage, and ~50% coverage of lower latitudes.

As we have previously reported (Kirk et al., *Proc. ISPRS TC IV*, 2010, http://www.asprs.org/publications/proceedings/orlando2010/files/KIRK.PDF) we have developed software and techniques for radargrammetric processing of Mini-RF images, including a sensor model for bundle adjustment and orthorectification in the USGS open-source cartographic system ISIS and a sensor for bundle adjustment, stereo DTM production, and orthorectification in the commercial system SOCET SET (© BAE Systems). In this abstract, we report on current efforts to use these tools to produce controlled image mosaics of the lunar poles and stereo DTMs of a variety of polar and nonpolar sites of scientific interest.

A significant setback to the production of such products was encountered in 2010, when a specially targeted stereo observation of the 71-km crater Jackson was acquired, with standard 44°–48° incidence angle on one orbit and reduced 24°–29° incidence imaging of the same area one orbit later. The high quality images yielded a DTM containing details as small as 50 m, but this DTM (and, by inference, the images) contained unexpected and serious geometric distortions, resulting in a height error of 4000 m amplitude relative to Lunar Orbiter Laser Altimeter data that varied smoothly (quasi-quadratically) along track.

Discovering the source of this error, the frequency of its occurrence (no such error was encountered in our earlier Mini-RF processing) and how to remediate it is now the main focus of our work. We are pursuing, and will report on, several lines of investigation:

1) Joint bundle adjustment of the Jackson crater Mini-RF images with optical images from the Lunar Reconnaissance Orbiter Narrow Angle Camera (LROC-NAC, 0.5 m/pixel), which should allow us to determine whether the distortions are present in both or only one radar image;
2) Collection of DTMs from additional polar and nonpolar image pairs, which will be of substantial scientific value in addition to testing for the presence of major image distortions; and
3) Compilation of a control network for the lunar poles, consisting of automatically measured tiepoints between overlapping Mini-RF images, plus a smaller number of manually measured ground control points. Bundle adjustment of this network will rapidly screen a large number of Mini-RF images for unexpected geometric distortions, and will pave the way for production of controlled radar image mosaics with pixel-level precision and accuracy, which will be invaluable in the correlative study of lunar polar geology and the putative ice deposits.

Please refer to overleaf for details.

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