Geophysical Research Abstracts
Vol. 13, EGU2011-11798, 2011
EGU General Assembly 2011


# Mini-RF: Mapping the Moon with Radar

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Introduction: Mini-RF is a lightweight Synthetic Aperture Radar (SAR) on NASA's Lunar Reconnaissance Orbiter, launched in June 2009. It is the sister instrument to the Mini-SAR which flew on the Indian Chandrayaan-1 lunar orbiter [1]. Mini-RF operates in either S band (12.6 cm) or X-band (4.2 cm), and can acquire data at two different spatial resolutions; baseline (150 meters) or zoom (30 meters). Mini-RF uses an hybrid dual polarization architecture, transmitting a left circular polarized signal and then receiving Horizontal and Vertical linear polarization signals, as well as the phase information between the two [2]. This arrangement preserves all of the information conveyed by the reflected signals and from these data, we determine all four Stokes parameters of the backscattered field. The Stokes parameters offer a very powerful tool to investigate the nature of lunar radar backscatter. In addition to calculating the response at both circular polarizations, and therefore also the circular polarization ratio, it is also possible to ascertain properties which should help to distinguish between multiple surface reflections versus volume scattering. This distinction is key to determine if the nature of the returned signal is due to an ice-regolith mixture, or simply rocks on the lunar surface.
Operations: Mini-RF activities primarily fall into one of three categories: 1. LCROSS support, 2. Polar mapping and 3. Non-polar imaging.
LCROSS Support: During the commissioning portion of the LRO mission, whilst the spacecraft was in an elliptical orbit, Mini-RF acquired data of potential impact sites in support of the LCROSS mission [3]. Mini-RF obtained S-band zoom data of a large fraction of the south polar region, including at least 5 potential LCROSS target sites. These were one of the data sets used by the LCROSS team to select their final target site inside Cabeus crater. Post impact, analysis of the Mini-RF data provides additional insight into the nature of the volatiles that LCROSS detected.
Polar Mapping: Mini-RF has conducted two polar mapping campaigns. The first occurred June-August 2010 and concentrated on acquiring S-zoom data within 20° latitude of both poles. This campaign was highly successful and succeeded in acquiring >95% areal coverage at both poles. Comprehensive polar coverage was obtained in both east and west look di-rections. Coverage include some significant small craters, inside the craters Rozhdestvensky and Peary craters near the north pole, which analysis of Mini-SAR data had shown to have elevated CPR values in their permanently shadowed interiors which is consis-tent with the presence of ice deposits [4]. In late November 2010 Mini-RF began another polar campaign, this one focused on acquiring X-baseline data within 10° of the north pole.
Non-Polar Imaging: Mini-RF has been taking advantage of excess downlink capacity to acquire nighttime imaging of non-polar targets. The Mini-RF target database includes the potential Constellation exploration and landing sites of scientific and exploration interest. During the first year of operations Mini-RF acquired ∼46% of the surface in S-band zoom. With additional imaging campaigns, we hope to increase that number.
Conclusions: Mini-RF is acquiring high quality data of the radar backscatter properties of the entire lunar surface. The data are archived in NASA's Planetary Data System are available to all lunar researchers.

References: [1] Spudis P.D. et al., (2009) Current Science, 96, 533. [2] Raney K. et al. (2010) IEEE Proc. In press [3] Neish C.D. et al., (2010) LPSC XLI. [4] Spudis P.D. et al. (2010) GRL 37, L06204, doi:10.1029/2009GL042259.