MINI-RF GLOBAL RADAR OBSERVATIONS OF THE MOON, M. M. McAdam[1], J. T. S. Cahill[1], W. Patterson[1], T. Aldridge[2], D. B. J. Bussey[1], E. P. Turtle[1], B. J. Thomson[1], C. D. Neish[1] and the Mini-RF Team, [1]The Johns Hopkins University Applied Physics Laboratory, Laurel, MD, [2]Northern Illinois University, Dekalb, IL (maggiemmcadam@gmail.com).

Introduction: Radar techniques have made significant advances in our knowledge of the lunar surface and subsurface from Earth-based and orbital perspectives [e.g., 1-2]. Now, with the Lunar Reconnaissance Orbiter (LRO), radar is again making significant scientific contributions and collecting information necessary for a return to the Moon. The Miniature Radio Frequency (Mini-RF) instrument aboard LRO is a hybrid polarization synthetic aperture radar that showcases the power of radar science in a very small package [3]. The most basic, yet critical, advance of Mini-RF is the contribution of high resolution (30 m/pixel) radar images over the entire lunar surface at 12.6 cm (S-band) and 4.2 cm (X-band) wavelengths. Mini-RF is conducting the first lunar farside radar mapping campaign, as these regions are not visible with Earth-based instruments [1]. Here, we present some in-progress Mini-RF global S-band zoom coverage maps.

Instrument: The Mini-RF instrument significantly augments previous Earth-based and orbital (i.e., Chandrayaan-1's Mini-SAR) radar data sets of the Moon collected at 3.8 cm, 12.6 cm and 70 cm [5-9]. What is unique about Mini-RF is its capability to determine all of the Stokes parameters, or quantitative measurements of polarized radar energy scattered from the lunar surface [1, 10]. The ability to use dual-polarized radar imaging to its fullest capabilities was not available in previous Earth-based radar experiments. Traditionally these radar surveys only produced two real Stokes parameters (linear polarized: S_1 and S_2 or circular polarized: S_1 and S_4 [10]) instead of the full set of four parameters [8]. However, recent technical improvements have been made that allow Mini-RF to collect and compute all four Stokes parameters at once. This aspect of Mini-RF allows opportunities for new scientific investigation in multiple perspectives.

Methods: Mini-RF S-zoom (12.6 cm) data strips are systematically being processed, projected, and integrated into global simple cylindrical mosaics (Fig. 1). The global products produced and displayed here include Clementine 750 nm visible map, the Stokes parameter (S_1), or the total average power in the returned signal, and the circular polarization ratio (CPR), or the same-sense (SC) polarization portion of the return signal divided by the opposite-sense (OC) [2, 3]. Radar S_1 and CPR products are helpful for investigations of lunar geomorphology and provide measures of surface roughness and estimates of surface composition, respectively. Partial mosaics are produced for every 100 orbits and quality checked before being added to the final global mosaics. Once added each 100 orbit partial mosaic is compressed and archived.

Results: The foremost objective of the Mini-RF instrument is to acquire high-resolution polar coverage in an effort to characterize potential water-ice deposits. A secondary, but no less significant, objective is to collect data at non-polar latitudes--most notably on the lunar farside. To date, Mini-RF has succeeded in acquiring data over 50% of the lunar surface in S-band zoom mode (Fig. 1-2).

A fundamental advantage radar S_1 and CPR maps provide is the ability to measure and differentiate lunar surface roughness and compositional (e.g., TiO_2 and ilmenite) properties at meter to decimeter vertical scales [2-6]. In this respect, we observe significant contrast in farside Feldspathic Highlands Terrane (FHT) S_1 backscatter and CPR relative to the nearside Procellarum KREEP Terrane (PKT) mare basalt flows. Mare basalts of the PKT tend to have a lower backscatter because they are smoother and have higher TiO_2 abundances at depths radar detects relative to highlands terranes which typically have very low to no TiO_2 abundances. However, South Pole-Aiken (SPA) basin, while distinct compositionally from the FHT with moderate TiO_2 abundances, does not show CPR values as low as PKT basalts of the nearside [11]. Maps suggest much of SPA basin has CPR similar to that of the FHT, with the exception of several craters and basins within SPA basin (e.g., Apollo, Oppenheimer, etc.). Orientale basin is also unusual as its rings and ejecta show higher CPR relative to the majority of the FHT [12]. These data suggest Orientale basin is characterized by significant proportions of boulder and ejecta deposits with relatively unweathered character, similar to smaller younger craters, considering the basins relatively old age (~3.9 Ga) [12].

Summary: Here the Mini-RF science team presents preliminary uncontrolled global S_1 and CPR global coverage maps of the Moon. These maps continue to be updated regularly and will be used for global analyses of lunar surface/subsurface roughness and estimates of composition. They will also be instrumental in expanding and identifying new regional areas of interest for research in the context of radar.

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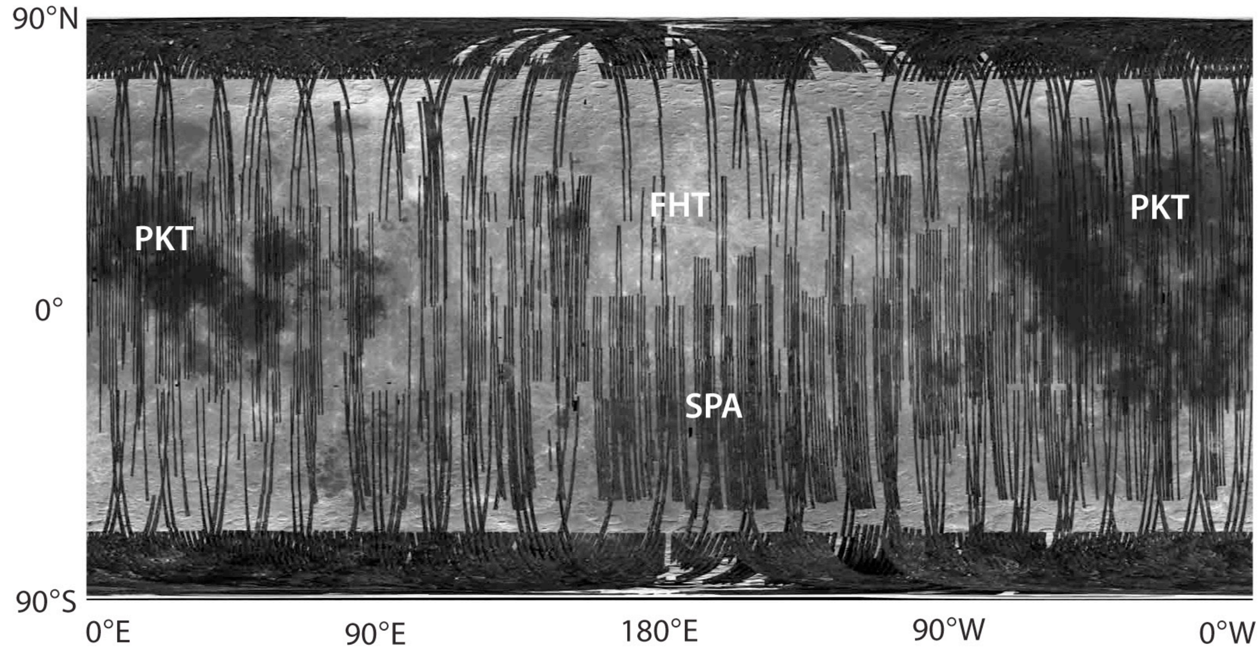

Figure 1: Mini-RF S_1 data over Clementine 750 nm background (128 pixels/degree).

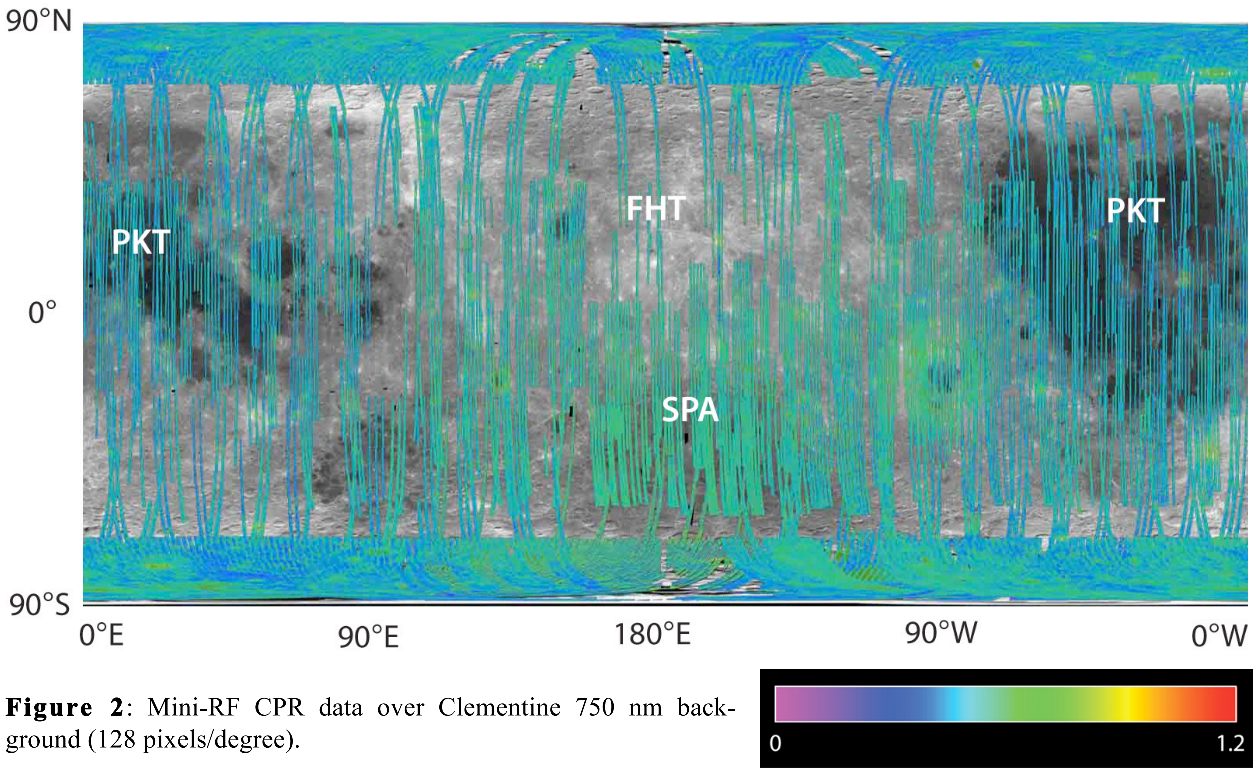

Figure 2: Mini-RF CPR data over Clementine 750 nm background (128 pixels/degree).