EXPLORING THE DIELECTRIC PROPERTIES OF THE LUNAR CRATER FILLS FROM THE MINI-RF OBSERVATIONS ONBOARD CHANDRAYAAN AND LRO. E. Heggy[1], B. Thomson[2], T.W. Thompson[1], E. Ustinov[1], W. Fa[3], B. Bussey[2] and P. Spudis[4]; [1]Jet Propulsion Laboratory, 4800 Oak Grove Dr., Pasadena, CA, 91109, USA, heggy@jpl.nasa.gov; [2]Applied Physics Laboratory, MP3-E169, Laurel, MD, 20723; [3]Institut de Physique du Globe, Paris, France; [4]Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX, 77058, USA.

Introduction. Unambiguous detection of potential ice inclusions in the lunar regolith in the poles of the Moon using polarimetric radar signatures remains a challenging task due to the complexities associated to surface and subsurface scattering mechanisms and the associated parametric space of inversions. The Clementine bistatic radar experiment reported finding evidence of ice in the vicinity of Shackleton crater [1], while Earth-based Arecibo radar observations suggested no significant differences between the sunlit and permanently shadowed walls of Shackleton crater [2]. In an attempt to reduce the ambiguities on such observations, two orbital synthetic aperture radars (Mini-SAR) on Chandrayaan-1 and Lunar Reconnaissance Orbiter (LRO) are imaging the lunar surface over the next 2 years with the main purpose to detect distinguishable polarimetric signature of ice in the shallow lunar subsurface in the shadowed polar areas [3]. Constraining the ambiguities associated to the dielectric properties distribution on the lunar surface and hence its role in the surface scattering and subsurface penetration is crucial to reduce the uncertainties on identifying ice inclusions in the lunar regolith. In this study, we use the H/V polarimetric ratio to estimate the dielectric variability of crater fills over polar and equatorial regions. Observed values will be compared to laboratory measurements of different lunar analog soils with different iron concentrations, different densities and ice enrichments in an attempt to provide an insight to the bulk composition of the investigated areas.

Polarimetric Response of Planetary Surfaces. The two mini-RF experiments consists of hybrid radar systems that are able to transmit in two circular polarizations, left and right and receive in two orthogonal ones, H and V. For a given pair of polarimetric images of the same area, the strength of the backscattered radar signal is mainly function of the roughness and dielectric properties of the surface [4]. Scattering from rough arbitrary surfaces, as the moon surface, typically produces similar response in H and V polarizations [4][5]. Hence, the comparison between the backscattered return from both polarizations H and V for both the S and X frequency-bands can be a valuable tool to understand the dielectric properties at those two different frequency-bands. Campbell et al., 2002[6], suggested a dielectric inversion model for rock-poor mantling dust based on the normalized ratios between the horizontal and vertical backscattering coefficient:

$$\varepsilon_{\min} = \left(\sin\phi / \sin\left[\cos^{-1}\left(\frac{\sigma^0_{HH}}{\sigma^0_{VV}} \right)^{0.25} - \phi \right] \right)^2$$

Where ϕ is the angle of incidence. The SAR angle of incidence on Chandrayaan and LRO is ~37.5°. In this analysis we consider smooth craters fills as rock-poor mantling dust surface, which allows us to apply the Campbell et al, 2002 dielectric inversion model to estimate a minimum value of the dielectric constant.

Figure 1, show both S and X bands images for both H and V polarizations for a small ~3.6 km-large crater inside the Amundsen crater in the south polar area. Backscattering coefficient in both images in S and X bands has been normalized to correct the slight difference between the incident angles on LRO and Chandrayaan (less then 3 degrees). Both images have ~ 60m resolution with range radiometric correction.

Preliminary Results. Figure 2 shows two 3-channels images with the ratios between H/V (Red), H-channel (Green) and V-channel (Blue) polarizations for S and X-bands. We observe that the ratios between the two bands vary as the amplitudes of surface versus volume scattering mechanisms changes. The crater northern wall is significantly brighter and thicker in X band indicating potential debris flows going downward the slop. The southern wall of the crater shows a different polarimetric response in S and X bands. In the central crater fill which we suggest being rock-free and only filled with smooth sediments (hypothesis supported by the weak backscattered signal in both S and X bands) the H/V ratios at S-band ranged from 0.73 in the center to 0.82 toward corresponding to a dielectric constant of respectively of 5.44 and 3.62. These dielectric constants are also consistent with the values obtained using the X-band data. The implications of those observations on the regolith composition will be discussed in the meeting presentation.

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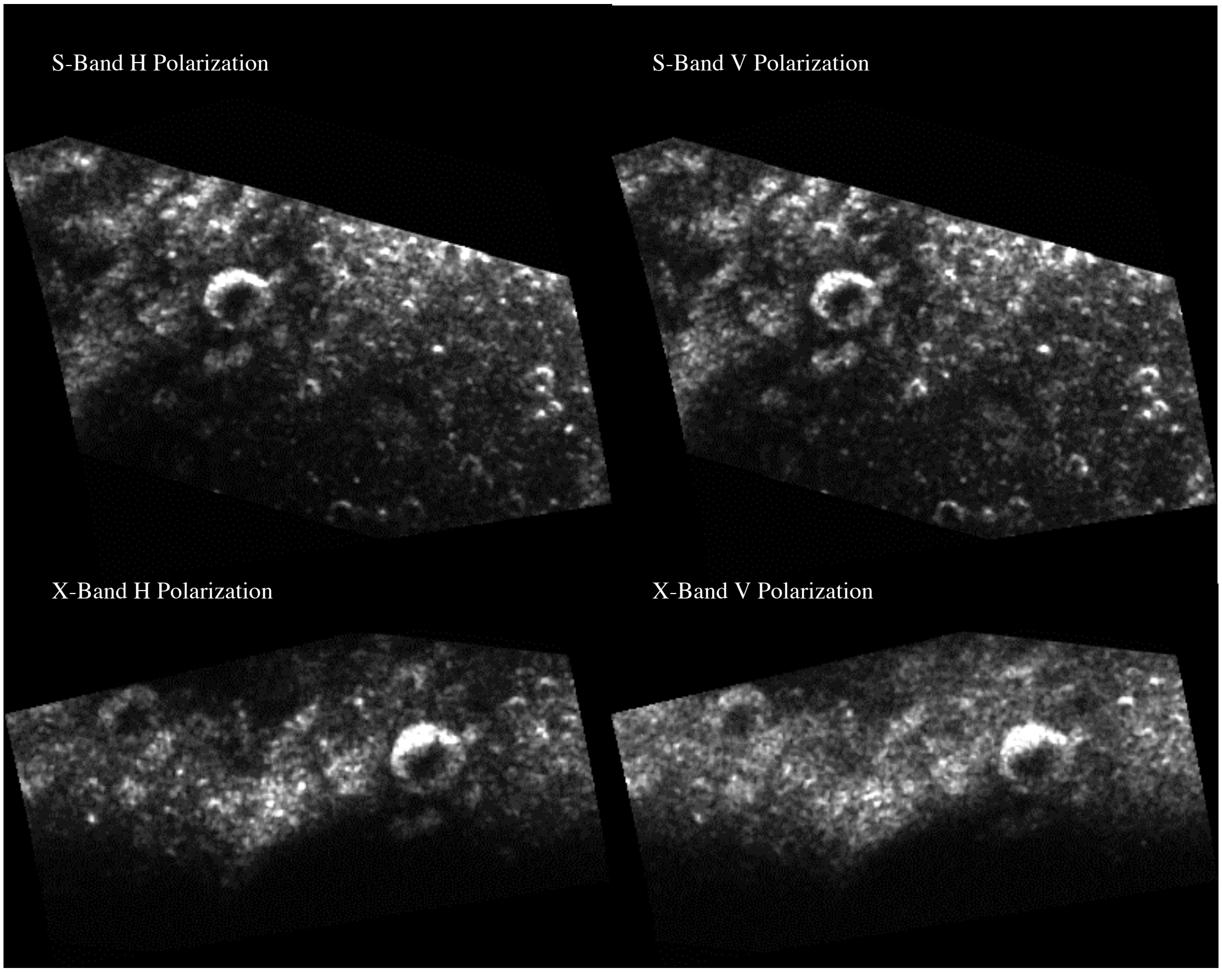

Figure 1. On the top, Chandrayaan S-band SAR 60m-resolution images for both H and V polarizations for a small ~3.6 km-large crater inside the Amundsen crater in the south polar area. On the bottom, LRO X-band SAR 60m-resolution images for both H and V polarizations for the same area.

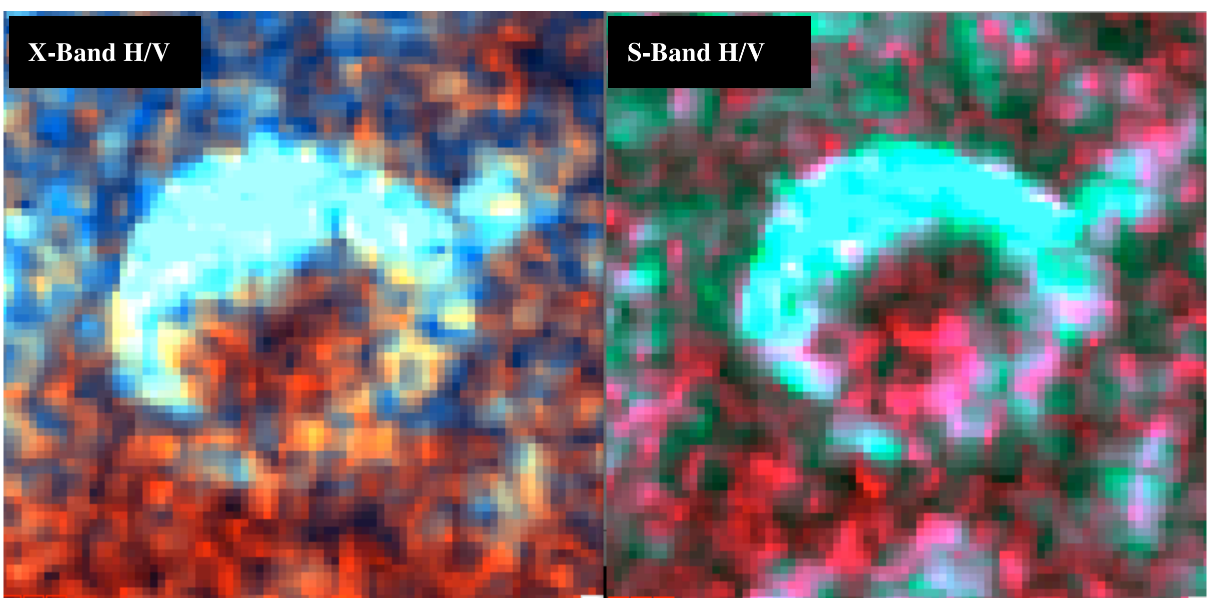

Figure 2. On the right, the S-Band 3-channels images with the polarimetric ratio H/V (Red), H (Green) and V (Blue). On the left, similarly, the X-Band 3-channels polarimetric ratio H/V, H and V. We observe that the ratios between the two bands vary as the amplitudes of surface versus volume scattering mechanisms changes. The crater fill is suggested to be smooth due to the weak backscattered variations between the S and X bands. This allow us to perform the dielectric inversion using the rock-poor mantling dust model [6]. At the S-band, the dielectric constant of the fill varied from of 3.62 near the rims to 5.44 in the center. The ration H/V is ~40% lower in the X-Band image at the center of the crater fill.