

DETECTION OF WATER ICE IN SHACKLETON CRATER ON THE MOON USING CHANDRAYAAN-2 L-BAND SAR DATA

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ABSTRACT

This study investigates the potential presence of water ice in the Shackleton Crater, located near the Moon's south pole and permanently shadowed. Using data from Chandrayaan-2's Dual Frequency Synthetic Aperture Radar (DFSAR)—the first full polarimetric SAR instrument used on the Moon—the study utilizes L-band SAR data for surface and subsurface analysis. Key indicators such as Circular Polarization Ratio (CPR) and Degree of Polarization (DoP) were analyzed to detect signs of subsurface ice. Elevated CPR values and DoP patterns helped generate a detailed water ice distribution map, identifying zones with possible ice deposits. These findings support future exploration and resource utilization missions.

NEED FOR STUDY

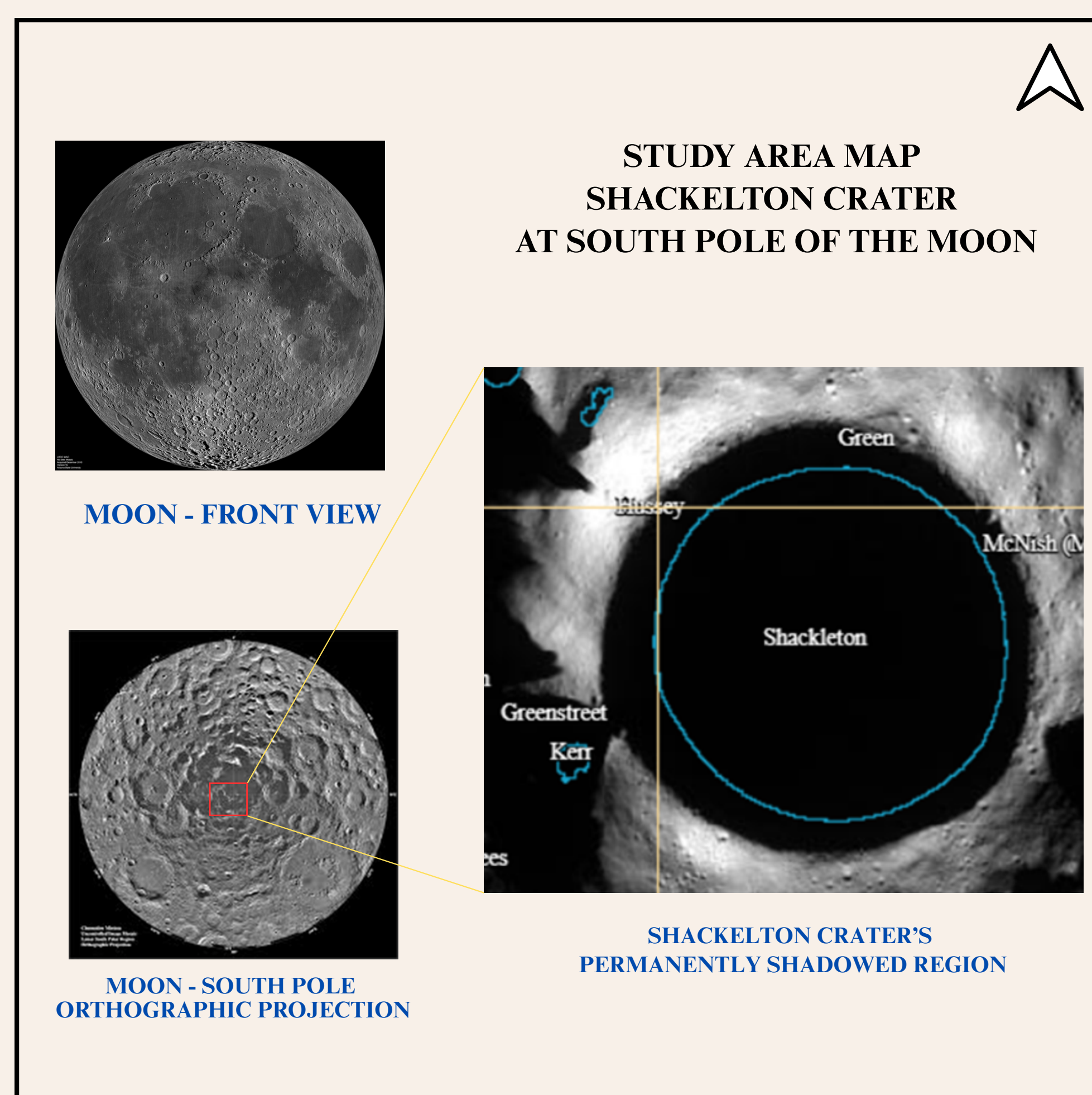
1. Polarimetric Data Utilization: Chandrayaan-2 DFSAR data offers a unique opportunity to apply advanced polarimetric techniques for water ice detection
2. Resource Identification for Future Missions: Accurate water ice mapping is vital for site selection for future landing missions and establishing lunar habitats.
3. Validation of Remote Sensing Techniques which can be applied to future missions targeting other celestial bodies, such as Mars.

OBJECTIVES

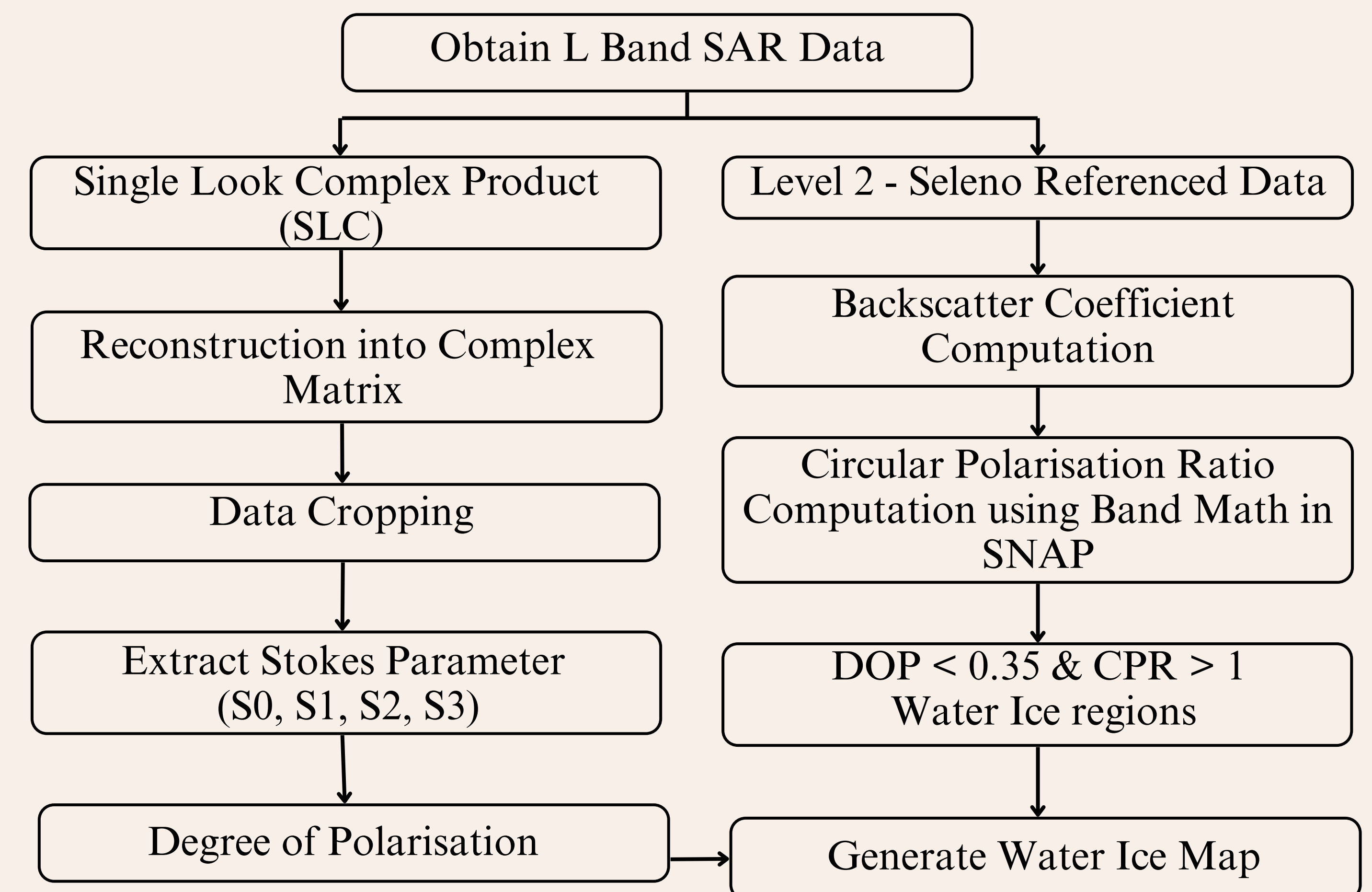
1. To infer L – Band SAR data and derive backscatter values.
2. To calculate the Circular Polarization Ratio (CPR) and extract polarimetric parameters.
3. To generate a water ice distribution map of Shackleton Crater.

STUDY AREA AND DATA PRODUCTS USED

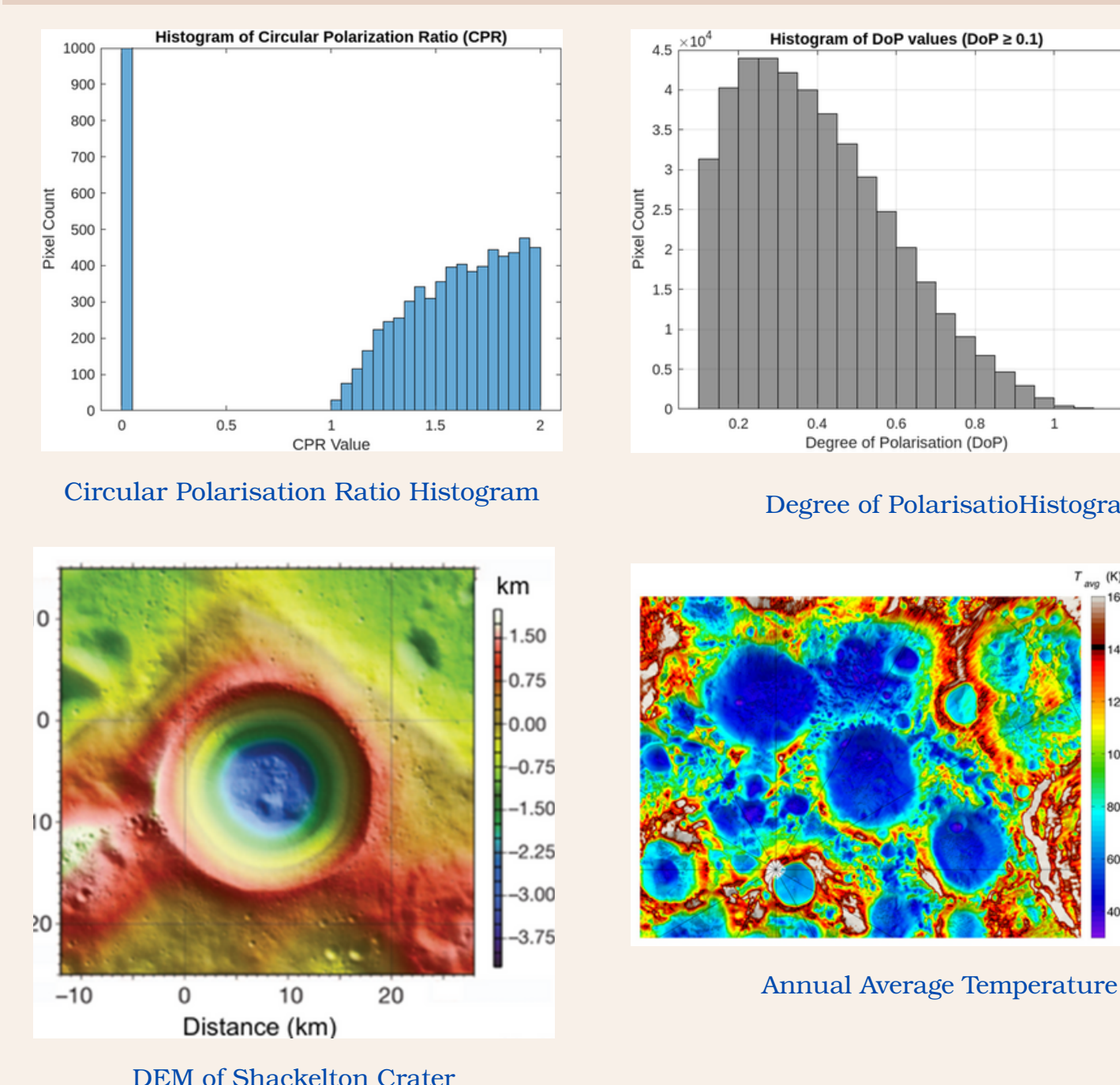
- The Shackleton Crater, a simple crater near the lunar south pole, has a diameter of 20.92 km.
- It is located at 89.67°S latitude and 129.78°E longitude, with a PSR area of 233.42 sq. km.
- Full Polarimetric (FP) L-band SAR data (1.25 GHz, ~24 cm) from Chandrayaan-2 (Product: ch2_sar_ncxl_20210216t084019987_d_fp_d32) was used.



METHODOLOGY



RESULTS



- Only 5.36% of the area shows low DoP, and 8.97% has high CPR, both indicating potential rough or depolarizing surfaces, linked to water ice.
- Polarization analysis showed that 0.9 sq. km. of Shackleton Crater met both key indicators for potential water ice presence—DoP < 0.35 and CPR > 1—highlighting regions with favorable scattering characteristics.

- Areas in the crater with temperatures below 110 K and slopes under 10° are ideal for ice accumulation.
- Shackleton Crater's floor, with slopes under 10° and temperatures below 110 K, offers ideal conditions for stable ice accumulation.

CONCLUSION

This study successfully leveraged L-band Synthetic Aperture Radar (SAR) data from the Dual Frequency SAR (DFSAR) onboard Chandrayaan-2 to investigate the presence of water ice within Shackleton Crater. The results revealed that 4.33% of the crater's area exhibited both high CPR values (>1) and low DoP values (<0.35), indicating multiple scattering and depolarization effects characteristic of subsurface volatiles such as water ice.