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P-band SAR for deformation surveying: advantages and challenges

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To date, mainstream SAR (Synthetic Aperture Radar) systems dominantly operate in X/C/L bands (wavelengths of 3.1–24.2 cm), which commonly experience low coherence and thereby degraded InSAR accuracy over densely vegetated terrains. The long wavelength (69.7 cm) P-band SAR, in contrast, holds the potential to address this challenge by penetrating through dense forests to collect highly coherent data takes. Here, we experimented using the NASA JPL (Jet Propulsion Laboratory)'s P-band AirMOSS (Airborne Microwave Observatory of Subcanopy and Subsurface) radar system to acquire repeat-pass SAR data over diverse terrains (14 flight segments) in Washington, Oregon, and California (USA), and comprehensively evaluated the performance of P-band InSAR for ground deformation surveying. Our results show that the AirMOSS P-band InSAR could retain coherence two times as high as the L-band satellite ALOS-2 (Advanced Land Observing Satellite-2) data, and was significantly more effective in discovering localized geohazards that were unseen by the ALOS-2 interferograms in forested areas. Additionally, P-band InSAR could better avoid phase aliasing to resolve high-gradient deformation. However, despite these advantages, P-band InSAR were less sensitive to subtle deformation than X/C/L band radars and faced similar challenges posed by waterbodies, thick snow covers, shadow and layover effects, and the side-looking configuration. Overall, our results suggest that P-band InSAR could be a revolutionary tool for measuring relatively high-gradient deformation under dense forest canopies.