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Quad-polarimetric radar measurements autonomously obtained with an ice-rover at Ekström Ice Shelf, East Antarctica

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Acquisition of quad-polarimetric radar data on ice sheets gives insights about the ice-fabric variability with depth and consequently can deliver essential constraints on the spatially variable ice rheology. Polarimetric measurements are collected manually in most ground-based surveys, discretely sampling a limited profile range. Measurements are time-intensive and often do not cover critical areas such as shear zones where field safety is a concern. Autonomous rovers can provide an alternative that optimizes for time, sampling resolution and safety.

Here, we present an autonomous acquisition technique of quad-polarimetric radar data using a rover. This technique is based on a previous layout that has proven its capacity to navigate in various snow conditions but did not yet actively trigger the geophysical instruments attached. We upgraded the rover with a novel Robotic Operating System (ROS2) that interfaces simultaneously with a real-time positioning GPS and an automatic phase-sensitive radio-echo sounder (ApRES) with multiple transmitters multiple receivers. Like this, the rover can autonomously steer to pre-destined waypoints and then take static measurements at those locations also in areas where field safety might be compromised. We demonstrate this proof-of-concept on the Ekström Ice Shelf Antarctica, where we acquired densely spaced polarimetric radar data measurements. The rover's operating system offers many opportunities for other measurement principles, e.g., densely spaced co-polarized data suitable for synthetic aperture radar (SAR) processing.