Investigation of bistatic scattering properties of snow using Ku-band radar

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1. Project description

The goal of the project is to investigate the potential of Ku-band bistatic radar for monitoring and parameter estimation of snow cover. We aim to acquire a comprehensive dataset (encompassing observations under different conditions, as well as in-situ measurements) for development and validation of new snow parameter retrieval methods which make use of Ku-band bistatic radar data. In August 2021, we deployed the Ku-band Advanced Polarimetric Radar Interferometer (KAPRI), a ground-based portable radar instrument, at the HSFJG for one week to monitor the Jungfraufirn area of the Aletsch glacier.

The KAPRI instrument allows deployment of following radar imaging techniques: 1) Polarimetry: By observing the difference between scattering of horizontally and vertically polarized radio waves, information about the scattering processes occurring within the observed scene can be inferred. 2) Interferometry: By analysing the phase of the scattered radio waves, small movements on the order of millimeters (e.g., glacier motion) can be detected. 3) Bistatic radar: By deploying an additional receiver in a location different from the transmitter's location, we can analyse the scattering of radio waves under a non-zero bistatic angle (i.e., the separation angle between the transmitter and the receiver from the point of view of the target).

The primary transmitter-receiver KAPRI device was deployed on the terrace of the Research Station (see Figure 1). The additional secondary receiver was deployed on the terrace of the East Ridge building (see Figure 2). A wireless synchronization link was established between the two devices. Several time series of observations were acquired at different times of day, with repetition times of 2-3 minutes, and total length up to 12 hours. In addition, calibration targets were deployed on the Junfraufirn for the duration of the measurements and retrieved afterwards (see Figure 3).

Preliminary analysis of data was carried out. Figure 4 visualizes data from a polarimetric acquisition performed by the primary device.

Figure 1. The primary KAPRI instrument deployed on the terrace of the Research Station, observing the Jungfraufirn area of the Aletsch glacier.

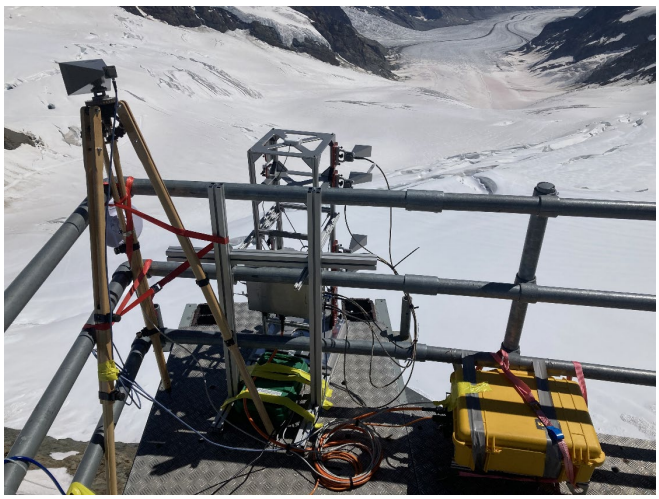

Figure 2. The secondary KAPRI receiver deployed on the terrace of the East Ridge building.

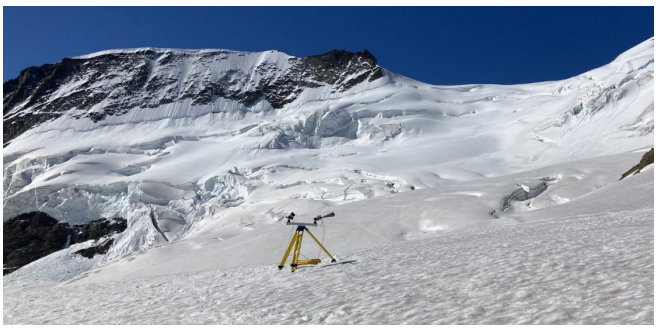

Figure 3. An active radar calibration target deployed in the Jungfraufirn area.

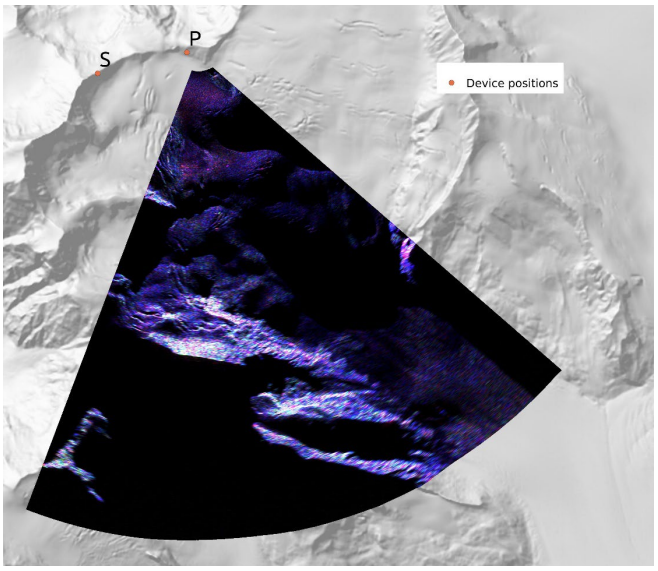

Figure 4. Backscatter signal received by the primary (P) KAPRI device, visualized in the Pauli polarimetric color basis which decomposes the observed scattering into 3 different mechanisms (red: dihedral scattering, green: volume scattering, blue: surface scattering). The predominantly blue color indicates that the surface scattering mechanism is dominant, in agreement with the expected presence of melt-freeze crusts on the surface. Map underlay source: swissALTI3D, swisstopo.

A follow-up measurement campaign is planned for winter/spring 2022, to acquire an additional dataset with field measurements and observations of fresh, frozen snow cover.

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