Exploring the Potential of Polarimetric Circular SAR for Glacier Monitoring: the Findel Glacier Case Study

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Polarimetric Synthetic Aperture Radar (PolSAR) sensors represent, nowadays, an established tool for the observation of glaciated areas. Being active microwave systems, SAR systems can operate in nearly all-weather conditions, during the long and dark polar winters. Moreover, exploiting the synthetic aperture concept, they are able to perform large scale and high-spatial resolution observations. At dry conditions, they combine the penetration capability of microwaves into snow/ice and the sensitivity of polarimetry to different scattering mechanisms. Therefore, PolSAR measurements are sensitive to glacier surface as well as near-surface features, especially at lower frequencies (e.g., L-band).

In the past few years, Circular SAR (CSAR) has become of increasing interest due to its enhanced (sub-wavelength) spatial resolution and 3-D reconstruction capability allowed by multi-angular measurements over 360° [1]-[3]. In this sense, CSAR has the potential to provide a better characterization of the imaged scene, compared to the conventional linear imaging modes, such as stripmap. In fact, the circular trajectory of the sensor allows to observe the scene from a number of different directions and to mitigate the dependency of the backscatter on the imaging geometry (i.e., flight direction and incidence angle).

The objective of this study is to provide a physical interpretation of L-band polarimetric CSAR (Pol-CSAR) measurements of the Findel Glacier, a temperate glacier located in the Swiss Alps. The data collection took place in October 2014 and March 2015, when two airborne campaigns were flown by the airborne F-SAR sensor of the German Aerospace Center (DLR) (see Fig. 1). Data analysis and interpretation are performed applying, for the first time, a polarimetric scattering model to Pol-CSAR data. For this, the model proposed in [4] is employed to retrieve snow and firn parameters of the shallow glacier subsurface [5], of relevance for the estimation of surface mass balance. Validation of the results is performed by means of ground measurements (i.e., GPR profiles, snow depth) collected in coordination with the SAR campaigns.
Fig. 1. Fully polarimetric high-resolution image in the Lexicographic basis (blue: HH, red: VV, green: HV/VH) obtained by the coherent addition of a complete single circular pass [3]. Scene size: 1:8 km by 1:8 km. Top: aerial view pointing to the North. Bottom: top view. Placemark in the center indicates the position of a Luneburg lens.

References


