

Multi-frequency modeling of polarimetric signatures over the Greenland ice sheet

Giuseppe Parrella¹, Georg Fischer^{1,2}, Kostas Papathanassiou¹, Irena Hajnsek^{1,2}

¹Microwaves and Radar Institute, German Aerospace Center (DLR), Wessling, Germany

²Institute of Environmental Engineering, ETH Zurich, Switzerland

Since the very first studies, polarimetric synthetic aperture radars (Pol-SARs) revealed a great potential for the study of glaciers and ice sheets. Besides the high spatial resolution and all-weather all-season operability inherited from conventional SAR systems, they can provide information about the dielectric and geometric properties of surface as well as near-surface layers as a result of the penetration capability of microwaves into dry snow and ice.

Despite most of the works performed over glaciated areas is focused on the amplitude (or intensity) of the backscattered signal at different polarizations, recent studies have shown that also the coherent nature of the polarimetric signature is essential. In particular, it has been shown that polarimetric phase differences between the co-polarized (co-pol) channels HH and VV can reveal details of the microstructure of snow and firn layers [1],[2]. Such information is relevant for the derivation of glaciological parameters like accumulation rate and surface mass balance [3] and its inversion from polarimetric data requires appropriate coherent models. However, the fact that the various ice zones are characterized by different subsurface structures hampers the generalization of such models and results.

In this paper, a multi-frequency study of polarimetric signatures over the different ice zones of the Greenland ice sheet is performed. The goal is to evaluate the validity of coherent scattering models across different glacier zones at different frequencies. For this, dedicated scattering components are considered according to the main scattering mechanisms expected in each zone [4]. Finally the potential of such models to identify the individual glacier zones and to invert glaciological parameters from PolSAR data is assessed. The study is conducted on multi-frequency (P-, L-, S-, C- and X- band) airborne Pol-SAR dataset acquired in May 2015, during the ARCTIC15 campaign, over five test sites located in the percolation zone and in the ablation zone of Greenland. The investigation is supported by available GPR measurements and existing literature.

[1] Leinss S., Parrella G. and Hajnsek I.: *Snow height determination by polarimetric phase differences in X-band SAR data*, JSTARS, vol. 7, no. 9, pp. 3794-3810, 2014.

[2] Parrella G., Hajnsek I. and Papathanassiou K.: *On the interpretation of polarimetric phase differences in SAR data over land ice*, GRSL, vol. 13, no. 2, pp. 192-196, 2016.

[3] Paterson W.S.B., *The Physics of Glaciers*, 3rd ed. Pergamon Press, 1994.

[4] Parrella G., Hajnsek I. and Papathanassiou K.: *Polarimetric decomposition of L-band PolSAR backscattering over the Austfonna ice cap*, TGRS, vol. 54, no. 3, pp. 1267-1281, 2016.