Exploring the Potential of TanDEM-X Dual-Polarization Time Series to Monitor Snow Accumulation on an Alpine Glacier

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Mass balance is a key indicator of the dynamics of a glacier. It is defined as the difference between the mass gained by accumulation and the mass lost due to ablation processes. Snow accumulation represents a major contribution to the accumulation term and its knowledge is therefore strictly required for the estimation of mass balance. So far, snow accumulation is being measured mainly by means of sparse weather stations which provide only point measurements. Snow maps for larger areas are obtained by spatially interpolating data from stations at different locations with the help of meteorological models.

In the last decades, space-borne radar remote sensing has led to significant developments in the field of glaciology, due to the large spatial coverage with a relative short revisit time and a high spatial resolution. Thanks to the penetration capability of microwaves into dry snow and ice, conventional SAR systems are able to sense the surface as well as subsurface layers of glaciers and ice sheets, providing a tool to access information about the structure of the shallow snow-cover.

This study investigates the potential of dual-polarimetric (HH/VV) TanDEM-X time series to monitor snow accumulation over the Aletsch glacier, in the Swiss Alps. In particular, co-polarization phase differences are employed to detect snowfall events, as shown already in [1] for the case of snow-covered soil. Furthermore, the propagation model described in [2] is adopted to link phase differences to fresh snow properties, like structural anisotropy, density and thickness, and to invert fresh snow depth from TanDEM-X data. Based on the inversion results, a simple algorithm has been developed to obtain an estimate of the temporal evolution of the snow height on the glacier surface. Preliminary results show that the proposed approach is able to provide a good estimate of the snow accumulation, as confirmed by snow depth measurements from a weather station nearby the glacier. However, a number of limitations remain, mainly related to the relatively low temporal sampling (11-day) offered by TanDEM-X and the need of some a priori knowledge about fresh snow density and structural anisotropy, which require further investigations.

[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] Leinss S., Loewe H., Proksch M., Lemmetyinen J., Wiesmann A. and Hajnsek I.: *Anisotropy of seasonal snow measured by polarimetric phase difference in radar time series*, The Cryosphere, vol. 10, pp. 1771-1797, 2016.