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Three-year study on feasibility of Snow Water Equivalent retrieval using X- to Ku band SAR

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The possibility of high-resolution SAR imagery to derive information on the Snow Water Equivalent (SWE) of seasonal snow cover is one of the main goals of the proposed CoReH$_2$O (Cold Regions Hydrology High-Resolution Observatory) mission. CoReH$_2$O is a candidate 7th Earth Explorer Core mission by the European Space Agency (ESA), currently in Phase A. The NoSREx (Nordic Snow Radar Experiment) campaign was initiated in 2009 to provide data for development of the CoReH$_2$O geophysical retrieval algorithm. The campaign provides a time-series of backscatter observations at X to Ku bands, the dual frequency bands proposed for CoReH$_2$O, from snow covered terrain in the boreal forest/taiga region. The campaign was designed to cover entire winter periods from snow free conditions to eventual snow melt-off. Backscatter measurements of snow cover are complemented by microwave emission (radiometer) observations and numerous in situ observations of snow, soil and atmospheric properties. The campaign thus provides a unique, near-continuous dataset of coinciding microwave observations of snow cover and diverse measurements of snow characteristics over several winter seasons.

The main instrument of the campaign is the ESA SnowScat scatterometer, installed for the entire campaign at a fixed location. The instrument provides a consistent time series of observations, allowing relating the backscatter signature to small scale changes in the snowpack at a high temporal resolution. During the second and third seasons of the campaign, SnowScat measurements were complemented by extensive airborne data acquisitions using the ESA X/Ku band SnowSAR instrument. The airborne data provide additional information on spatial variability of the backscattering signal, and allow demonstration of the CoReH$_2$O SWE retrieval concept. As a reference to backscatter observations, the campaign provides routinely both manual and automated measurements of snow properties throughout the season. In addition, several Intensive Observation Periods (IOPs) conducted during the experiment provide accurate information on snow cover properties by e.g. means of near-infrared photography and computer tomography of casted snow samples. Together these data give the information needed for active microwave forward models to simulate the backscatter properties of snow, and to validate the baseline retrieval algorithm for CoReH$_2$O. Results indicate that 1) the increase in snow volume is correlated with the proposed channel combination of X/Ku on both co- and cross polarizations during the dry snow season, in agreement with forward models of snow backscatter 2) the state of the snow background (frozen/thawed, moisture content) has significant impact on the signal in particular at X-band and should be accounted for in SWE retrieval algorithms.