Relating SAR backscatter to in-situ measurements and models of snow liquid water content: A study based on an ASAR time series combined with snow station measurements

Christoph Rohner, Tobias Jonas, David Small
Remote Sensing Laboratories, Department of Geography, University of Zurich, Switzerland

SAR sensors can be used to map wet snow cover, which is potentially valuable for many hydrological applications such as flood forecasting and snow-runoff modeling. To improve the linking of SAR based wet snow data with snow hydrological models, we need to better understand the relationship between SAR backscatter and snowpack properties such as the liquid water content. This study presents a detailed analysis of wet snow qualifiers from different remote sensing products with combined snow observation and snowpack model results.

The data sets used as input consist of over 400 Radiometrically Terrain Corrected (RTC) Envisat ASAR backscatter products covering Switzerland from 2002-2012 as well as isolated radar backscatter measurements acquired with other satellites, such as dual-polarisation imagery acquired by RADARSAT-2. The ground-based parameters are measured by snow stations operated by SLF at over 100 measurement stations distributed throughout the Swiss Alps. Each station records meteorological and snow-state parameters at 30 minute intervals. Based on these measurements, a physical snowpack model is run, from which hourly profiles of liquid water content are extracted.

A suitable set of IMIS locations is selected to represent all elevation levels, and tests for discrimination between wet snow, dry snow, and wet soil are evaluated. For dates when RADARSAT-2 dual-pol backscatter values are available, they are used to investigate polarisation-dependent differences between backscatter from wet snow vs. wet soil.

The ASAR time series is used to investigate connections between estimated snow liquid water content and SAR backscatter. The sensitivity of the backscatter to snow-state parameters such as the estimated local depth of the melting process and snow liquid water content is compared statistically. Other parameters measured at the IMIS stations, including snow depth, layered snow temperature, as well as air and ground temperatures, are also evaluated. Once the signal’s sensitivity to the snow-state parameters has been evaluated, a verification of the results using a more extensive set of IMIS stations distributed throughout Switzerland can be carried out.