An Alternative Concept for Remote Sensing of Snow Mass

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Information on Snow-Mass (SM) or Snow-Water-Equivalent (SWE) is required for run-off modelling during the melt season. For many years the main concept for SWE retrievals was based on the penetration and volume scattering of microwave radiation in dry snow using active or passive microwave sensors. The microwave spectrum is of advantage for its independence from daylight and insignificant disturbance by clouds. However the method fails for wet snow and thus during the melt season. Wet snow results in full absorption of the microwave radiation over a short distance on the order of one wavelength. Furthermore problems arise due to the high sensitivity of microwave scattering on snow-grain size, leading to the need for snow-structure information. This is why we like to propose an alternative concept that we plan to investigate in a new ESA study.

Our focus will be on radar sensors and on wet snow or snow containing at least one humid layer to screen signals from the underlying ground. Studies of radar backscattering from landscapes have shown that wet snow has much lower returns than most situations of snow-free ground. This is a direct consequence of the strong microwave absorption combined with the fact that surface scattering of snow is small, too. We will look for optimal radar frequency and polarisation with essentially no returns from wet snow. Then the radar return will be proportional to the fraction a=1-s of snow-free areas within the observed pixel and s is the snow-cover fraction. For a given landscape and season, s is correlated with snow depth and thus with SWE. The relationship depends on topography, surface roughness and vegetation, i.e. on parameters that are constant over longer time scales than the snow cover. Due to the analogy with visible radiation an optimal SWE sensor may consist of a radar and an optical imager. Synergy between the different spectral regions will avoid ambiguities, reduce retrieval errors and hopefully lead to further applications.