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Potential benefits of employing combined active and passive microwave observations in retrieval of snow water equivalent

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ABSTRACT

Spaceborne high frequency (Ku- and X-band) radar sensors have been proposed as tools for sensing snow physical properties at a higher spatial resolution compared to present passive microwave instruments. Indeed, one of the candidates for the European Space Agency's next satellite in the series of Earth Explorer Core missions is CoReH2O, a dual frequency SAR mission dedicated to observations of the cryosphere. Among the priority activities for mission preparation are the analysis of active snow water equivalent (SWE) retrieval methods, including studies of the synergistic use of CoReH2O measurements with other observational data, such as microwave radiometer observations (AMSR-E, SSM/I, SMOS).

We present initial results of a study examining the potential benefits of combined active and passive microwave observations of snow cover. We apply a suite of forward backscatter and emission models to examine the potential sensitivity of active and passive microwave signals to snow cover in varying land cover and vegetation conditions. The study emphasizes the differing sensitivities to snow parameters due to mixed pixel effects at different spatial resolutions. Theoretical cases are complemented by data from field campaigns and extensive land cover and e.g. vegetation information at selected test areas. These are used to drive input parameters of the applied models to demonstrate the challenges and potential benefits of synergistic application of active and passive microwave signals.

A synthetic scenery generator (SSG) was constructed for running forward backscatter and passive microwave models as well as an iterative retrieval algorithm for active, passive and synergistic SWE retrievals. The aim of the simulator was to facilitate the generation of synthetic sceneries of backscatter and microwave brightness temperature response. The forward backscatter models included in the scenery simulator are the ENVEO sRT model and a semi-empirical backscatter model, based on HUT snow emission model. The passive forward model calculating the brightness temperatures employs the HUT snow emission model.

The SSG can be used to generate both completely artificial sceneries for sensitivity studies, or to generate synthetic sceneries of actual environments, given the proper input data. In addition, the retrieval algorithm included in the SSG is able to numerically solve SWE from real active and passive satellite observations. The retrieval model is tested against the synthetic sceneries using different parameterizations with active, passive and synergistic cases. The functionality of the synergistic retrieval algorithm is also demonstrated with observational data from TerraSAR-X and AMSR-E in Sodankylä region in the Northern Finland.