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COSMO-SkyMed Backscattering Simulations using DMRT and Snowpack Models

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In this paper the integration between the Dense Media Radiative Transfer (DMRT-QMS) and SNOWPACK models has been investigated in order to simulate snow parameters and the backscatter at X band (9.6 GHz) from nivo-meteorological data.

The test area is a mountain area located in the eastern side of the Italian Alps, where an automatic snow and weather station acquired data during the winter 2014/2015.

The role of stickiness (τ) in DMRT-QMS model was investigated by using experimental data of backscattering collected from COSMO-SkyMed and snow data generated by SNOWPACK. The simulations of τ were carried out to avoid its arbitrary assumption usually employed in literature. The relationships between τ and both ice volume fraction ($\phi\phi$) and coordination number (nc) have been moreover assessed.

The DMRT and SNOWPACK backscattering simulations were have successively been compared with COSMO-SkyMed backscattering measurements showing a significant agreement, although for a limited dataset.

In this work, two different models were integrated in order to estimate backscattering coefficient (σ0) from snow cover. The first is SNOWPACK, which is a physically based model that simulates the snowpack characteristics starting from nivo-meteorological data, and can be used in a variety of scenarios. In our case, the nivo-meteorological data were acquired from an automatic weather station located in the test area. The second is an electromagnetic model based on Dense Media Radiative Transfer theory in QuasiCrystalline Approximation (QCA) of Mie scattering of densely packed Sticky spheres (DMRT-QMS). DMRT (QCA) is the most advanced model to simulate emission and backscattering from snow covered soils. [1-5] [1] [2-7].

SNOWPACK is the presently available more complete model to define the microstructure and the layering of snow and to generate the input data requested by DMRT except for the stickiness. Stickiness (τ) is an adimensional parameter, which has been introduced to take into account the cohesion force among the snow particles. τ was estimated in DMRT-QMS as a function of snow parameters simulated by SNOWPACK. Usually, in literature, τ is assumed as an arbitrary parameter in order to fit backscattering simulated data to experimental ones. This work eventually aims at investigating the capability of relating τ to one or more quantities generated by SNOWPACK and estimating it through an electromagnetic approach.

Finally, the results obtained from our simulations were compared with satellite data measured by COSMOSkyMed (CSK) on the test area. A reasonable agreement (R2 =0.78) between estimated and measured σ0was observed.