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Snow Microwave Radiative Transfer (SMRT): A New Model to Simulate Snow-Microwave Interactions for Active and Passive Remote Sensing

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Forward modeling of snow-microwave interactions is commonly used to comprehend remote sensing data from active and passive sensors. Though different models are yet available for that purpose, a joint effort has been undertaken in the past two years within the ESA Project "Microstructural origin of electromagnetic signatures in microwave remote sensing of snow". The new Snow Microwave Radiative Transfer (SMRT) model primarily facilitates a flexible treatment of snow microstructure as seen by X-ray tomography and seeks to combine advantages of existing models. In its main setting, SMRT considers radiation transfer in a plane-parallel snowpack consisting of homogeneous layers with a layer microstructure represented by an autocorrelation function. The electromagnetic model, which underlies permittivity, absorption and scattering calculations within a layer, is based on the improved Born approximation. The resulting vector-radiative transfer equation in the snowpack is solved using spectral decomposition of the discrete ordinates discretization. SMRT is implemented in Python and employs an object-oriented, modular design that i) provides an intuitive and fail-safe API for basic users ii) enables efficient community developments for extensions (e.g. for improvements of sub-models for microstructure, permittivity, soil or interface reflectivity) from advanced users and iii) encapsulates the numerical core which is maintained by the developers. For cross-validation and inter-model comparison, SMRT implements various ingredients of existing models as selectable options (e.g. Rayleigh or DMRT-QCA phase functions) and shallow wrappers to invoke legacy model code directly (MEMLS, DMRT-QMS, HUT). We give an overview of the model and show results from different validation schemes.