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SMRT: A new, modular snow microwave radiative transfer model

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Forward models of radiative transfer processes are needed to interpret remote sensing data and derive measurements of snow properties such as snow mass. A key requirement and challenge for microwave emission and scattering models is an accurate description of the snow microstructure. The snow microwave radiative transfer model (SMRT) was designed to cater for potential future active and/or passive satellite missions and developed to improve understanding of how to parameterize snow microstructure.

SMRT is implemented in Python and is modular to allow easy intercomparison of different theoretical approaches. Separate modules are included for the snow microstructure model, electromagnetic module, radiative transfer solver, substrate, interface reflectivities, atmosphere and permittivities. An object-oriented approach is used with carefully specified exchanges between modules to allow future extensibility i.e. without constraining the parameter list requirements.

This presentation illustrates the capabilities of SMRT. At present, five different snow microstructure models have been implemented, and direct insertion of the autocorrelation function from microtomography data is also foreseen with SMRT. Three electromagnetic modules are currently available. While DMRT-QCA and Rayleigh models need specific microstructure models, the Improved Born Approximation may be used with any microstructure representation. A discrete ordinates approach with stream connection is used to solve the radiative transfer equations, although future inclusion of 6-flux and 2-flux solvers are envisioned. Wrappers have been included to allow existing microwave emission models (MEMLS, HUT, DMRT-QMS) to be run with the same inputs and minimal extra code (2 lines). Comparisons between theoretical approaches will be shown, and evaluation against field experiments in the frequency range 5-150 GHz. SMRT is simple and elegant to use whilst providing a framework for future development within the community.