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Multiple scattering and emission from inhomogeneously layered snowpack

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The vector radiative transfer (VRT) equation is an integral-deferential equation to describe multiple scattering, absorption and transmission of four Stokes parameters in random scatter media. From the integral formal solution of VRT equation, the lower order solutions, such as the first-order scattering for a layer medium or the second order scattering for a half space, can be obtained. The lower order solutions are usually good at low frequency when high-order scattering is negligible. It is not feasible to continue iteration for obtaining a high order scattering solution because too many folds of integration would be involved.

For example, in the space-borne microwave remote sensing the Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave/Imager (SSM/I) employed seven channels of 19, 37 and 85*GHz* with dual polarization and 22 *GHz* with only vertical polarization. Multiple scattering from the terrain surfaces such as snowpack cannot be neglected at these channels. The discrete ordinate and eigen-analysis method has been studied to take into account multiple scattering and apply it to remote sensing of atmospheric precipitation, snowpack, etc. A snowpack was modeled as a layer of random and dense spherical particles, and the VRT for a layer of uniformly dense spherical particles has been numerically studied by the discrete ordinate method.

However, due to surface melting and refrozen crust presence, the snowpack undergoes stratifying and might have inhomegeneous profiles of the ice grain size, fractional volume and physical temperature etc. It becomes necessary to study multiple scattering and emission from stratified snowpack of dense particles. However, the discrete

ordinate and eigen-analysis method cannot be simply applied to multi-layers model, because numerically solving a set of the VRT equations is difficult.

By stratifying the inhomogeneous media into multiple thin slabs and employing the first order Mueller matrix of each thin slab, an iterative method is developed to derive high orders scattering solutions of the whole scatter media. High-order scattering and emission from inhomogeneous stratifying media of dense spherical particles are numerically obtained. The brightness temperatures at low frequency, such as 5.3 *GHz*, without high-order scattering and at SSM/I channels with high order scattering are discussed. This approach is also compared with the conventional discrete ordinate method for a uniform layer model. Numerical simulation for an inhomogeneous snowpack is also compared with the measurements of microwave remote sensing.