# Reflectance and polarization of light from particulate medium

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We have measured linear polarization of reflected radiation from several particulate targets. When comparing to a model (Peltoniemi 2005), we have noticed several percent disagreement in the forward scattering direction. In order to explain this discrepancy we have improved the ray-tracing model by larger shape variations, by an EM scattering component for small dust or frost bites (based on Peltoniemi 1997, with new Monte Carlo integration and semi analytical singularity computation), and for a possibility to form thick transparent medium from small ray-traced layers by adding/doubling (based on Peltoniemi 1993). We have tested various hypothesis to explain the difference:

1. Shape of the grains. The roughness of the grains was varied from smooth to rough, and overall shape from spherical to ellipsoids and to almost needle-like. This results in large changes in the BRF shape, but polarization is less affected.
2. Orientation of the grains. We assume grains lie flat side up. BRF is changed significantly, and forward polarization actually increased slightly, but not enough to explain the differences.
3. Air bubbles. We tested with large geometric optics bubbles, spherical (Mie) bubbles, Rayleigh-bubbles and EM-bubbles. All of these increase polarization in all directions, too little forward too much elsewhere.
4. Fluffy surface. We assume surface is covered by small wavelength-scale frost or dust. We note that these scatterers can yield backscattering peak and negative polarization, but not much for forward polarization.
5. Clustered fluffs. We assume covering scatterers cluster to flat formation. Some hints for forward polarization can be seen.
6. Anisotropy of the polarizer. We tested for the anisotropy error of the calcite polarizer. We observe about 1° angular deviation, but to explain the difference this error should be antisymmetric for 180° turn, but it is not.
7. Cracked polarizer. If the field of view is wider in some direction than in the other, this could explain both angular error and the symmetry. Visual inspection shows indeed some cracks, and there is about 2° difference in the width of the FOV. This can explain part of the disagreement, but not the fact, that there is also a dependence on target properties, e.g. wet or dry snow.

The answer remains still open, but best candidates are that part of the discrepancy is due to measurement error (hypothesis 7), and other part could be due to interfering fluffs (5) on the grain surface and orientation(2).

The measurement system is being updated with a polarized lamp and an alternative wire grid polarizer to validate the results. The model is to be completed with rougher top surface and oriented dust clusters on grain surface. New measurements on orientation distributions and micro-structures are required.