Light Scattering from Agglomerated Debris Particles: Comparison with Feldspar Data

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Using the discrete dipole approximation (DDA), we model light scattering by a sample of feldspar particles and compare the results against laboratory measured light-scattering properties at two visible wavelengths. The shape of feldspar particles is approximated with the so-called agglomerated debris particles [see, e.g., Zubko et al., 2009, J. Quant. Spectr. Rad. Trans. 110, 1741–1749]. These model particles have irregularly shaped, agglomerate morphology with material packing density being 0.236. We consider a large number of sample particles (500+) that makes our computational results statistically reliable. The refractive index is assumed to be m = 1.5 + 0i and nearly coincides with what was measured in experimental feldspar samples. The light-scattering response is computed over a wide range of particle sizes spanning the range from 0.14 to 4.5 micron. We compare the non-zero light-scattering Mueller-matrix elements of agglomerated debris particles with those of well-characterized experimentally measured feldspar samples at blue (0.442 microns) and red (0.633 microns) wavelengths [Volten et al., 2001, JGR 106, 17375–17401]. It is important to stress that we also account for the polydispersity of feldspar particles, adapting the size distribution measured by Volten et al. The only completely free parameter in our comparisons is the small-size cut-off of the sample, which was not known. The significance is that both the light scattering and the measured properties of model and real particles agree very well at both blue and red wavelengths simultaneously. While some tweaking of the particle parameters could achieve some improvement, the fits are remarkably good. We suggest that the reason for the good fits is not that the agglomerated debris particles exactly represent those of the sample particles, but rather that both sets of particles belong to a class of highly irregular particles, whose high degree of irregularity dominates the resulting scattering behavior, suppressing the effect of any characteristic morphological features. The ability to replicate the light-scattering Mueller matrix elements at two wavelengths using particles having the same physical properties as those of the experimental sample is the primary advantage of using the agglomerated debris particles over more regularly shaped particles.