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Impact of surface roughness on scattering by irregularly shaped wavelength-scale particles

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Numerous past studies have shown how surface roughness on particles may substantially alter the single-scattering properties of small particles. When roughness is added on simple, regularly shaped model particles, their complexity is often substantially increased. Other past studies have shown how the single-scattering properties of simple and complex particles also tend to differ. As the past studies have employed simple shapes in the investigation of the impacts of roughness on scattering almost exclusively, their findings may not be representative for all types of particles. In particular, surface roughness may have substantially weaker impact on scattering by particles with more complex shapes.

We have investigated the impact of small-scale surface roughness on irregular, real-like dust particles. The shapes of the model particles were retrieved through stereogrammetry from real dust particles. The roughness model then created small mounds and craters at their surfaces, such that the overall volume of the particles is not (significantly) changed.

Our results show that the introduction of surface roughness alters the single-scattering properties also for irregularly shaped complex particles. Further, the impact is found to be consistent and systematic. However, even if as much as 90% of the particle surface is roughened, the impacts are not major, and they occur mainly at the side- and especially at the backscattering angles. For lidar quantities, for example, the impacts can be quite significant, while radiative fluxes are probably only very slightly affected. The impact of roughness is, in general, stronger for larger size parameters.