Measuring the detector-observed impact of optical blurring due to aerosols in a laboratory cloud chamber

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Abstract

Remotely sensed images are degraded by atmospheric effects including absorption and scattering of light by aerosol particulates, which not only attenuate the signal but can cause blurring due to forward-scattered light accepted by the optical imaging system. Proposed theoretical aerosol scattering models provide a method for simulating the contrast and spatial detail expected when imaging through atmospheres with significant aerosol optical depth. This work explores closure comparisons between modulation transfer functions (MTFs) obtained from directly-measured images and MTFs calculated from theory using measured cloud properties. The closure experiments are carried out in Michigan Technological University's laboratory cloud chamber in which cloud droplet number density and size distribution are directly measured. Images of a binary knife edge target were taken with an optical detector on the other side of a water cloud generated through reduction of pressure in the humidified chamber. The key results of this closure experiment include: 1) The theoretical expression for the aerosol MTF is likely overly simplistic and does not account for broad particle size distributions. 2) The significance of optical blurring from light scattering by aerosol particles depends sensitively on the properties of both the particles and the imaging system.