Extinction matrix for cirrus clouds in the visible and infrared regions

Alexander A. Konoshonkin*, Anatoli G. Borovoi, Natalia V. Kustova, Victor A. Shishko, and Dmitriy N. Timofeev

V. E. Zuev Institute of Atmospheric Optics SB RAS, Akad. Zuev sq. 1, 634055 Tomsk, Russia

**Presenting author (sasha_tvo@iao.ru)*

The state of polarization of the transmitted radiation varies along the propagation path in scattering media if the media contains a lot of independent nonspherical particles with preferential orientations. This phenomenon is caused by the interference of the incident field with the fields scattered in the forward direction by each particle. One of the examples of such scattering media are cirrus clouds consisting of ice crystals, since the crystals are often oriented quasi-horizontally. The abovementioned interference effects are completely described by the extinction matrix. For ice crystals of cirrus clouds, the matrix was considered by several authors. In particular, the extinction matrix was numerically calculated in [1] with the DDA for small particles. The PO calculations of the extinction matrix for large particle were recently reported in [2,3]. However, [2,3] are based on the assumption of a narrow particle size distribution; as a result, quickly oscillating functions appear. In nature, crystal size distributions are wide, which largely suppresses the oscillating interference effects.

The talk presents the extinction matrix for cirrus clouds calculated for the visible and infrared regions using the physical optics approximation for natural crystal size distributions. The cirrus clouds are modeled as a statistical ensemble of hexagonal ice plates distributed over size and orientations according to the gamma and Gaussian laws, respectively. Then, the extinction matrices as functions of the incident wavelength, incident direction, crystal size, and crystal orientation are numerically calculated for the first time. It is shown that the off-diagonal elements of the matrix are negligible. Therefore, the extinction in cirrus clouds is described with good accuracy by the scalar exponential law.

References

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