Features of spectral dependence of single-scattering characteristics for crystalline clouds

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This work considers the extinction, scattering, and absorption coefficients and quantum survival probability as basic characteristics of single scattering. The physical optics method and the Mie theory are used to calculate these characteristics for individual particles of an ice cloud and for ensembles of crystals with various values of the particle aspect ratio and different parameters of the particle size distribution. The features of extinction, scattering, absorption, and single-scattering albedo are illustrated for various microphysical parameters of the crystal system at visible and infrared wavelengths. Particular attention is paid to the Christiansen spectral regions. According to the results of our numerical study, the most pronounced spectral dependences of the single-scattering characteristics are observed for a system of large predominantly oriented plates and wavelength-sized particles. The difference in their behavior is due to variations in the physicochemical properties of the particles even for identically shaped crystals. With the same concentration of the selected particles, the spectral dependence of the optical characteristics (e.g., extinction coefficient) for the large plates is more pronounced (by orders of magnitude) than for the small particles.

For a system of large translucent horizontally oriented plates, analytical expressions are presented to calculate the absorption and extinction coefficients. These expressions allow us to quantify the influence of microphysical parameters of the particles and their refractive index on the spectral dependence of the optical characteristics for a polydisperse medium containing large horizontally oriented plates with a minimal expenditure of computer resources.

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