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Extinction of radiant energy by large atmospheric crystals with different shapes

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For a complete description of the extinction process, the extinction matrix (EM) is introduced. The equations determining the elements of the EM for large semi-transparent crystals are obtained in the framework of the method of physical optics. The results of numerical study of the characteristics of visible and infrared radiation extinction by large crystals are shown. The plate crystals, the hexagonal and rectangular columns distinctly stand out among all large particles by the character of radiation extinction. For these crystals, the extinction factor may oscillate around its asymptotic value equaling 2.
For the individual plates and the columns also an ensemble of these particles, it is illustrated as results of calculations of the characteristics of the extinction (the most considerable elements of EM, the extinction efficiency factor, the extinction coefficient, and characteristics of the effect of polarization on the extinction) depend on the microphysical, optical and orientational properties of the particles, and wavelength of the visible and IR radiation. For the single crystals, it is demonstrated as the various attenuation features provide both neutral and spectral behavior of integral characteristics of the extinction. It is shown that the shape, the sizes, the aspect ratios, the complex refractive index, the orientation of the crystals, the wavelength and the polarization state of the incident radiation influence on extinction of radiation. It is shown that the most expressive and stable features of energy and polarization characteristics of the extinction are observed in the midinfrared region, despite the fact that the ice particles significantly absorb radiant energy of this spectrum. It is shown that particles with different aspect ratios, even belonging to the same shape of crystals, can form both negligible and noticeable effect of polarization on the extinction. Conditions of occurrence of the spectral behavior of the extinction coefficient in the visible and near-IR wavelength ranges are determined for large crystals. It is demonstrated that the polarization characteristics of the extinction can reach several tens of percent for IR wavelengths. At visible and near-infrared radiation, these features of the extinction can be observed only for the plates and rectangular columns with sustainable spatial orientation. For other large crystals, the extinction for these spectrums is determined by the average particle sizes and concentration, but does not depend on the wavelength and the refractive index of the particles.