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ANALYTIC EXPRESSIONS FOR AEROSOL LIGHT-SCATTERING CROSS SECTION

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ABSTRACT

The light-scattering cross section is an intrinsic property of an aerosol, and is important for understanding and quantifying Earth's radiative balance. The dependence of this cross section on wavelength, which is parameterized by the Ångström exponent å, yields information on the sizes of particles that provide the dominant contribution to the scattering; aerosols for which the scattering is dominated by particles much smaller than the wavelength have larger values of å than aerosols for which scattering is dominated by much larger particles, for which å is near zero.

For an aerosol consisting of spherical particles of uniform composition, the light-scattering cross section can be calculated by integration over the size distribution given knowledge of the scattering efficiency of a particle, which depends on the ratio of the radius of the particle to the wavelength and on the index of refraction. However, this calculation is computationally laborious and provides no insight into the dependences of the light-scattering cross-section on quantities such as wavelength or relative humidity. Additionally, the scattering efficiency contains many oscillations at a variety of scales, nearly all of which are unimportant for calculation of the light-scattering cross section as they will be smoothed out by the spread of the aerosol size distribution.

Accurate analytic expressions for the scattering efficiency are presented which allow exact computation of the scattering cross section for aerosol size distributions that are parameterized by lognormals or gamma functions. Additionally, these expressions explicitly illustrate the dependence of the scattering cross section on wavelength (and thus yield analytic expressions for the Ångström exponent) and relative humidity.

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