Volume Integral Equation Method Optimized for Black Carbon-Containing Aerosol Particles

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We propose a robust scheme of volume integral equation method (VIEM) for light scattering and absorption by black carbon-containing aerosol particles: the fractal-like aggregates of absorbing black carbon (BC) spherules that may be mixed with non-absorbing (or weakly absorbing) compounds. Conventionally, a particle volume has been uniformly approximated as a collection of small volume elements (dipoles) on a cubic lattice (CL). In the proposed scheme, each BC spherule is considered as a spherical dipole with original size, while remaining particle volume occupied by non-absorbing compounds is approximated by a collection of dipoles on a CL. We call this as Spherule-Retained-Cubic-Lattice (SRCL) scheme. For several model BC-containing particles, positive absorption bias of ~30% persistent in the CL scheme is success-fully eliminated in SRCL scheme. The interaction matrix (i.e., discretized volume integral operator) associated with the SRCL scheme has less simple structure compared with that for CL scheme. We propose some key strategies for mitigating memory and computational costs in solving the matrix equation in the SRCL scheme.

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