Preface

Light scattering and radiative transfer is central to a number of diverse scientific disciplines ranging from atmospheric to medical optics. This volume is composed of two parts. In the first part, current problems and methods used in modern studies of single light scattering are considered. The chapter by Barkey et al. is aimed at experimental studies of single light scattering by ice crystals. The work is of great importance for ice cloud remote sensing and also for climate studies because it enhances our knowledge of the single scattering patterns of ice crystals. There are a lot of theoretical results in the area of light scattering by nonspherical particles, but ice clouds also contain irregularly shaped particles and the characterization of corresponding shape and size distributions for realistic cloud scenarios is not a trivial one. Light scattering by small nonspherical particles as studied in the framework of discrete dipole approximation (DDA) is considered by Zubko. Unfortunately, the technique cannot be used for scatterers much larger than the wavelength of light, such as those occurring in ice and dust clouds. On the other hand, the technique is very powerful with respect to modeling of particles of complex shapes, chains, and aggregates. The papers of Sun et al. and Cole et al. address recent advances in the finite-difference time-domain (FDTD) methods. Sun et al. reviews the FDTD technique for modeling of light scattering by arbitrarily shaped dielectric particles and surfaces. The emphasis is on the fundamentals of the FDTD algorithms for particle and surface scattering calculations and the uniaxial perfectly matched layer and the novel scattered-field uniaxial perfectly matched layer absorbing boundary conditions for truncation of the FDTD grid. Both DDA and FDTD are based on the direct solution of Maxwell equations without reference to the wave equation, which is usually used in the treatment of light scattering by some simple shapes such as spheres and spheroids. These approaches are capable of considering the particles of arbitrary shapes. However, the computation speed is low and particles much larger than the wavelength cannot be considered. The chapter of Cole et al. introduces some recent developments of the finite-difference time-domain method and some new applications. Using what is called a nonstandard finite-difference model, the accuracy of the FDTD algorithm can be greatly enhanced without using higher-order finite difference approximations on a coarse numerical grid. This algorithm was checked by computing whispering gallery modes in the Mie regime for infinite dielectric cylinders. To compute light propagation in dispersive materials the FDTD algorithm must be modified. The recursive convolution algorithm is one such modification, but it is computationally intensive and sometimes unstable. The authors introduce stability criteria, and show how to improve the accuracy while decreasing computational cost.

The second part of the book is aimed at the application of radiative transfer theory and respective optical measurements for the characterization of various turbid media. Stamnes et al. considers radiative transfer in coupled systems such as, e.g., the ocean–atmosphere interface. Airborne spectral measurements of shortwave radiation are reviewed by Schmidt and Pilewskie. It is demonstrated how spectral information can be used for cloud and aerosol remote sensing. The final chapter of the book, prepared by Kokhanovsky and Rozanov, is aimed at the determination of snow grain sizes using satellite observations. The asymptotic radiative transfer theory is used for the satellite snow grain sizing. Nowadays, this technique has become standard for the solution of inverse problems of snow optics.

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This book is dedicated to D. Tanre, a pioneer in the area of aerosol remote sensing from space, on the occasion of his 60th birthday.

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