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ORIGINAL ARTICLE

Radiation transfer through atmospheric aerosol media with anisotropic scattering

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Abstract Radiation transfer in atmospheric aerosol media with general boundary conditions has been studied for anisotropic scattering. The considered aerosol medium assumed to have specular and diffused reflecting boundary surfaces and in the presence of internal source. The radiation transfer scattering parameters as single scattering albedo, asymmetry factor, scattering, absorption, extinction efficiencies and anisotropic scattering coefficient have been calculated using the Mie theory. The problem with general boundary conditions is solved in terms of the solution of source-free problem with simply boundary conditions. Pomraning-Eddington approximation is used to solve the source-free problem. For the sake of comparison, a weight function is introduced and used in two special forms. The calculated partial heat fluxes with the two methods are compared and showed good agreement. Some of our results are found in a good agreement with published data.

Keywords Radiative transfer · Aerosols · Reflective boundaries · Variational Pomraning-Eddington technique

1 Introduction

Aerosols play an important role in the atmospheric radiation calculations (IPCC 2007), which affect the earth radiation balance through direct effects and indirect effects. The scattering and absorbing solar radiation affect on the micro-physical properties of the clouds, which mainly constitute of different types of aerosol particles. The aerosol particles are averaged to be assumed as spherical, so the optical properties describing the interaction of the solar radiation with the aerosol particles can be calculated by using Mie theory (Bohren and Huffman 1983). Because the variety of the aerosol particles radii in real atmosphere, it is important to average the optical properties in a unit volume over the aerosol size distribution $n(r)$. The usual used size distributions for aerosol particles are the Log-normal and modified gamma (e.g., d'Almeida et al. 1991; Deepak and Gerbers 1983). Variations of the vertical structure of microphysical and optical parameters of aerosols depend on location, latitude, season of the year, and characteristics of the global scale aerosol source (Gavrilova and Ivlev 1996). Therefore, such calculations are important in studying climate change or global warming and its effect on the earth.

The atmospheric media vary between many types of aerosols as, Clean continental, Urban, and Maritime. Clean continental aerosol medium consists of water soluble (WS1) and dust like (DL) aerosol particles. The main reason of the presence of the water-soluble (WS) in the aerosol media is the gas to particle conversion and it consists of various kinds of sulfates, nitrates, and others (Hess et al. 1998). The dust aerosol particles scatter and partially absorb solar radiation, and they have the potential to change outgoing terrestrial radiation fluxes ("greenhouse effect") due to their relatively large particle sizes for far-traveled dust. The larger particle sizes are known to be found near dust source regions (Lacis and Mishchenko 1995). Urban aerosol type contains WS1, DL and soot aerosol particles. Soot aerosol is the major absorbing aerosol component in the atmosphere, and it has an eigen high absorption cross section (10 m^2/g) (Faxvog and Roessler 1978). It can play, as many other aerosol particles, a role in studying radiative transfer, climate change and global warming (Hansen et al. 1980). Maritime aerosol class con-

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