Editorial

Introduction to the Special Issue “Radiative Transfer in the Earth Atmosphere”

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This Special Issue aims at addressing the recent developments towards improving our understanding of the diverse radiative impact of different types of aerosols and clouds. Radiation plays multiple essential roles in the earth system, including the impacts on the earth radiative budget at the top of the atmosphere and the surface, heating/cooling radiative rates, photolysis rates, photosynthetic active radiation (PAR), and radiative forcing at the top of the atmosphere (see Table 1). This Special Issue presents modeling studies and results of measurements that are focused on quantifying the radiative impact, considering various aerosol and cloud types. Aerosol types considered include smoke from biomass burning Lu and Sokolik [1], Alston and Sokolik [2], mineral dust Li and Sokolik [3], urban aerosol Alston and Sokolik [2], and stratospheric aerosol Madronich et al. [4]. Several types of absorbing aerosols are analyzed by Tegen and Heinold [5], using the global climate models. Also, regional aerosol types were examined (e.g., Panchenko et al. [6]). This study presented an analysis of Siberian aerosol based on measurements. Optical properties of ice clouds are reviewed (Yang et al. [7]).

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Table 1. Radiative quantities, their importance and examples of studies addressing them.

Quantity	Importance	Study Examples
Net radiation at the surface	Affects surface processes	Rahman, et al. [8]
Surface radiative budget	Affects surface processes	Lu and Sokolik [1]
Radiative forcing	Affects the earth energy balance	Alston and Sokolik [2]
Heating rates	Affects the temperature profile	Quijano, et al. [9] Tegen and Heinold [5]
Actinic flux	Controls atmospheric gaseous chemistry	Jeong and Sokolik [10]
PAR (photosynthetic active radiation)	Affects photosynthesis processes	Xi and Sokolik [11]

The main radiative quantities are summarized in Table 1, in which examples of studies are given for each quantity. The importance of each quantity is explained.

Some studies used various approaches by combining observations and models. For instance, Li and Sokolik [3] presented a quantitative assessment of the radiative impact of dust aerosol, focusing on the Central Asia region. Their study combined satellite observations and a regional model WRF-Chem-DuMo. Lu and Sokolik [1] examined the radiative impact of smoke using WRF-Chem-SMOKE in conjunction with satellite observations. This study examines fires that occurred in Yakutsk, 2002. In turn, Alston and Sokolik [2] used a one-dimensional radiative transfer model constrained by observations to quantify the radiative forcing by regional aerosol types focusing on the U.S. Southeast.

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They reconstructed the chemical composition of representative aerosol types and used it in optical modeling. Optical models were incorporated in a one-dimensional radiative transfer code to compute the radiative forcing.

General circulation models have been used as a powerful tool to estimate the radiative impacts of aerosol and cloud through a detailed representation of their significant processes, such as their emissions, formation in the atmosphere, and transport. Jeong [12] presented a modeling study examining the aerosol impacts on weather. Focusing on black carbon and mineral dust, Tegen and Heinold [5] reported results of semidirect radiative effects, which were simulated as residuals of the total radiative effect and the instantaneous direct forcing. Their study also reported modeled heating rates.

Hall [13] has presented an assessment of approaches to quantify the effects of clouds on the radiation amplification factor for the UV radiation. Data of spectrophotometer measurements at 10 U.S. sites were used for the analysis.

Rahman et al. [8] reported the regional distribution of net radiation over different ecohydrological land surfaces. Satellite data were analyzed in conjunction with the SEBS (surface energy balance system) model.

Observations using satellites present a unique way to characterize aerosol. Várnai and Marshak [14] reported an analysis of cloud-related variations in aerosol properties. This study analyzed the data of aerosol and clouds from the Moderate Resolution Imaging Spectrometer (MODIS) and the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP). Their results point out the need for improving the detection of aerosols near clouds.

Yang et al. [7] presented a review of ice cloud optical models for passive satellite remote sensing. Authors summarize the key optical characteristics of ice particles used in several satellite sensors, addressing the historical development of ice cloud models.

Castellanos et al. [15] presented results of simulations of aerosol observations from an instrument on the geostationary satellite.

Wei et al. [16] reported an analysis addressing satellite data assimilations using the NCEP global data assimilation system. They assessed the impacts of aerosol on brightness temperatures.

Collectively, papers presented in this Special Issue address important current problems in quantifying radiative characteristics of major aerosol types and clouds through modeling and observations.

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