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Editorial

Topical issue on optical particle characterization and remote sensing of the atmosphere: Part I

Increasing our understanding of the Earth–atmosphere system has been a scientific and political priority for the last few decades. This system not only touches on environmental science, but it has applicability to our broader understanding of planetary atmospheres in general. While this issue focuses primarily on electromagnetics, other fundamental fields of science, including fluid and thermodynamics play major roles. In recent years, significant research efforts have led to advances in the fields of radiative transfer and electromagnetic scattering from irregularly shaped particles. Recently, several workshops and small conferences have taken place to promote the fusion of these efforts. Late in 2013, for instance, two such meetings took place. The Optical Characterization of Atmospheric Aerosols (OCAA) meeting took place in Smolenice, Slovakia to promote a better understanding of microphysical properties of aerosol particles, and the characterization of such atmospheric particles using optical techniques. A complementary conference was organized in Nagoya, Japan, the 3rd International Symposium on Atmospheric Light Scattering and Remote Sensing (ISALSaRS), whose goal is to fuse the advances achieved in particle characterization with remote-sensing techniques. While the focus of these meetings is slightly different, they represent the same aspects of this rapidly growing field.

This Topical Issue is the first of two parts. Within this issue we analyze different aspects of the problem of atmospheric characterization and present a broad overview of the topical area. Research includes theory and experiment, ranging from fundamental microphysical properties of individual aerosol particles to broad characterizations of atmospheric properties. Since this is an active field, we also have encouraged the submission of ideas for new methodologies that may represent the future of the field.

There are 16 contributions included in this first part. This issue commences with an experimental study by Zhang et al. [1] who made a characterization of black-carbon aerosols in an urban center in China. We cannot emphasize enough the importance of well-characterized systems. These are critical to all aspects of analysis, especially model validations of any remote-sensing study. In order to better characterize particles, new detection techniques must be developed and used. Pan et al. [2] present an overview of the application of fluorescence that can be used to provide additional characterization to individual aerosol particles. Another characterization technique has been developed by Berg et al. [3] that can be used to produce holographic images of particles, providing morphological information. Such information is critical for model development, as the morphological properties play a major role in the optical properties of small particles. Such morphological effects are studied in detail by Zubko et al. [4]. A common morphological property of aerosols is surface roughness. This roughness can affect different segments of the scattering phase function. Kemppinen et al. [5] study the impact of this property. In order to characterize a large polydispersion of particles, some approximations must be made to simplify the resulting scattering properties. To address this issue, Videen et al. [6] explore the use of mixing rules for heterogeneous, irregularly shaped particles. Ultimately, these properties become incorporated into models using parameterization schemes. Zhang et al. [7] present one such method for irregularly shaped ice particles. As particle size grows, the polarization properties eventually approach that of an extended surface. At some point there is a transition region between these two fundamental systems that is explored by Videen et al. [8]. The use of scattering properties in retrieval algorithms was presented by Bangsheng et al. [9], who retrieved aerosol single-scattering albedo from the ratio of diffuse horizontal and direct normal fluxes measured from a multi-filter rotating shadow-band radiometer (MFRSR). Increased knowledge of light-scattering properties coupled with more sophisticated algorithms is allowing the retrieval of different classes of complex aerosols within datasets. For instance, Sugimoto et al. [10], studied the mixing states of Asian dust using a polarization particle counter. Instrumentation used for characterizing the atmosphere has continued to increase

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in complexity, providing a gradual progression. Xie et al. [11] outline their methodology for atmospheric retrievals using multiple channel polarization lidar. Validation is a critical step in algorithm development and several contributions deal with related issues. Sun et al. [12] outline results from a model of polarized atmospheric radiation for the correction of satellite sensors with polarization-dependent measurements, and validate the results using PARASOL data. Zhang et al. [13] performed validations of surface radiation budgets using Baseline Surface Radiation Network (BSRN) data. Min et al. present simulation [14] and observational [15] data of surface pressure measurements of an O_2-band differential absorption radar system. New phenomena can lead to new instrumentation that can help to further characterize the atmosphere. As outlined by Kocifaj et al. [16], the quantification of the effect of charge on light-scattering suggests a potential application of using two-channel backscattering measurements to detect the threat of lightning.

The second part of this Topical Issue will be published in a subsequent volume of this Journal.

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