Appl. Phys. B 60, 313 (1995)

Applied Physics B Lasers and Optics

Editorial

Multiple-Scattering LIDAR Experiments

Multiple-scattering effects must be taken into account in any light-scattering experiment in which the density of scatterers increases and the optical depth τ exceeds 0.1. This situation is often met in the case of LIDAR signals returning from the atmosphere. Quantitative statements about multiple-scattering contributions to LIDAR returns are of great practical importance in the analysis of measurement data. Therefore, multiple scattering must well be understood itself, and calculation schemes for the quantitative prediction of its contributions to the signals are needed for the given experimental conditions.

This feature issue of Applied Physics B focuses on approaches to the calculation of multiple-scattering contributions to the LIDAR returns from aerosols and clouds. The papers presented result from an international joint effort stimulated by a workshop group called MUSCLE (MUltiple SCattering LIDAR Experiments). The purpose of this feature issue is not to give a collection of papers on multiple scattering, but to present a LIDAR-oriented overview of the state-of-the-art in this field. To this end, a big effort to explain the characteristics, limitations and advantages of the different methods has been made by all groups involved in the task of comparison.

Within the MUSCLE group, various theoretical approaches to multiple scattering are currently being pursued. They all start from the transport equation for radiation in a dense medium and develop different methods to account for multiple scattering by atmospheric particles. One common feature is that they all need some form of modelling and approximation in order to render the solution computationally possible and affordable; a validation of the results is therefore necessary. Most models have already been compared to experimental data or other theoretical calculations. However, these comparisons generally address different quantities which are affected by multiple scattering, and it is difficult to appreciate the relative performance of the models. Confronted with this difficulty, the group decided to apply all models and algorithms to a common problem. Because there existed no complete set of experimental multiple-scattering LIDAR data at the time of definition of the task, a numerical experiment was chosen as a valid and convenient alternative. All participants were to calculate the LIDAR returns for the same specified cloud, instrument and geometrical parameters.

Six individual papers describe in detail the different approaches used for the calculations. The models include approximations to the theory of radiative transfer (L.R. Bissonnette, E.P. Zege et al.), Monte-Carlo calculations (P. Bruscaglioni et al., D.M. Winker and L.R. Poole), a stochastic model of the process of multiple scattering (A.V. Starkov et al.) and an approach exploiting a recursive generalization of Mie scattering (C. Flesia and P. Schwendimann). The last paper of this feature issue, jointly written by all authors, contains a comparison of the results obtained from each approach when applied to the same physical situation.

The preliminary results were mainly presented at the 6th MUSCLE workshop held in Neuchâtel, Switzerland, on January 26 to 28, 1993. More groups have recently become involved in this field, and we hope that they will join our efforts.

Geneva
Berne
October 1994

C. Flesia
P. Schwendimann