

Design and Validation of an Elastic Lidar Simulator for Testing Potential New Systems for Aerosol Typing

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A novel lidar simulator based on first principles is presented. Here we describe our approach and initial results for simulating raw lidar signals and system SNR from assumed system parameters and aerosol optical properties. We also include a validation method and sensitivity studies. The main motivation behind this work is to show how low cost and physically small lidar systems would perform in various atmospheric conditions. A small network of such sensors could potentially provide aerosol particle properties across a large area for a relatively low budget.

Aerosols are small solid or liquid particles suspended into the Earth's atmosphere, originating from anthropogenic activities or natural sources. Several studies have highlighted their impact both on human health and on the Earth's climate. Aerosols can cause respiratory problems, bronchitis, and overall lower life expectancy. They can also directly interact with radiation through scattering and absorption; they alter cloud properties, lifetimes, and the Earth's surface albedo, and thus indirectly affect the radiation equilibrium. The aerosol field is subject to rapid temporal and spatial changes, hence the increased difficulty to accurately quantify their net effect on the planetary radiative budget and air quality.

Using lidar systems it is possible to characterize aerosol particles and derive their vertical distribution and concentration. Lidars can operate on the ground or on-board airborne and satellite platforms to provide coverage of the aerosol field at larger geographical scales. For example, the CALIOP lidar system on board the CALIPSO satellite provides spatio-temporal vertical distribution of aerosols and clouds, while ground-based systems like the ones operated by EARLINET provide range-resolved aerosol and cloud properties at various wavelengths on a continental scale. However, the sensors employed in the aforementioned examples may face difficulties in providing highly localized data, and are expensive to build and maintain. Typically new lidar systems are based on existing systems as reference due to challenges in accurate forward modelling of system performance.

The simulator presented herein is capable of using instrument component parameters and, based on known atmospheric scenarios, returns the aerosol optical properties and signals. In particular, the simulator accounts for molecular effects, system overlap different far boundary solutions and the possibility of depolarization channels, and is programmed to function at any wavelength. The simulator's performance is currently being validated against [EARLINET](#) and [PollyNet](#) datasets.