LIDAR POLARIZATION STUDIES OF THE LOWER ATMOSPHERE

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ABSTRACT

The polarization properties of the backscattering of a lidar pulse from the lower atmosphere have been measured under a variety of meteorological conditions. The ruby lidar system used in this study transmits linearly polarized radiation at both 694.3nm and 347.2nm and has four independent receiver channels. Each channel can be equipped with rotatable polarizers and retarders as well as band-pass filters so that all four components (I,Q,U,V) of the Stokes vector of the backscattered signal can be measured for a single transmitted pulse. From the measurements of these components it is possible to derive many polarization features of interest as a function of position in the atmosphere. (e.g. The total intensity, the depolarization ratio, the rotation angle and the ellipticity)

Measurements have been in progress with this system for several years and it has been found that the atmosphere displays a great variation in polarization signatures which are dependent upon the meteorological conditions. The most pronounced effects are observed under conditions of high atmospheric turbidity and as we have recently reported[1] clouds present a particularly interesting set of features.

In this paper we present a summary of our recent results. It has been found that clouds, at both wavelengths often display a strong increase in depolarization, δ ($\delta = P_r/P_e$ where P_r and P_e denote backscattered power polarized perpendicular and parallel to the transmitted polarization) with penetration depth reaching values which are generally of the order of 0.5 to 0.8. On some occasions in cirrus clouds δ has been found to have values exceeding unity. The rotation angle χ often exhibits a strong negative rotation at the cloud base and then a positive rotation with increasing penetration depth. In even rather clear air, layers associated with the mixed layer boundary and inversions display pronounced polarization discontinuities which appear to arise from haze and aerosol accumulations. The results in general show definite correlation between the lidar measurements, and air quality parameters (coefficient of haze and suspended particulate loading) being locally monitored. Quantitative analysis of the lidar returns utilizing known polarization and wavelength dependences of Rayleigh and Mie scattering will be presented.

Reference

1. S.R. Pal, A.I. Carswell, "Polarization Properties of Lidar Backscattering From Clouds", Appl.Optics 12, 1530(1973)