COMPARISON OF LIDAR METHODS FOR REMOTE MEASUREMENT
OF AIR POLLUTANTS

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ABSTRACT

This paper presents quantitative comparisons of several single-ended lidar techniques for the remote measurement of gaseous pollutants. These techniques are divided into two groups. The first group is based on the measurement of energy scattered directly by the gas of interest. The gaseous scattering processess considered are ordinary fluorescence, resonance fluorescence (also called resonance scattering), Raman scattering, and resonant (or nearly resonant) Raman scattering. The second group is based on the measurement of a characteristic differential absorption produced by the gas of interest at two discrete wavelengths, using energy scattered back toward the receiver by a remote reflector other than the gas of interest. The remote reflector may be intermixed with the gas of interest, as is the case with aerosols and atmospheric gases (principally nitrogen), or they may be fixed reflectors such as terrestrial objects or retroflectors.

The detectability of a given material will depend on the magnitude and characteristics of the optical interaction with that material. The main characteristics of interest are the cross section, the response time, and the spectral response of the material relative to both the transmit and receive functions of the lidar. These characteristics and their implications for remote sensing will be reviewed for the four direct scatter processes and for the differential absorption technique.

The characteristic behavior of the direct backscatter technique is different from the differential absorption technique with respect to sensitivity, concentration of material, and the effect of range. For these reasons, the direct backscatter processes cannot be compared directly to the differential absorption technique. The two techniques can be compared for specific material and system configurations, however. This paper describes specific lidar system

configurations and gives the calculated performance level for these systems in both the direct backscatter and differential absorption modes for a wide variety of pollutant monitoring situations.

The results of this comparison of techniques indicate that the differential-absorption lidar technique can provide adequate range and sensitivity for a wide variety of pollution monitoring applications involving a number of interesting pollutant materials. No other single technique appears to provide these capabilities for such a wide range of materials.

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