AN ALL-PURPOSE COMPUTER PROGRAM FOR LIDAR SIMULATIONS AND REDUCTION OF LIDAR DATA

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A general computer program has been written for the dual purpose of simulating lidar return signals and extracting H_2O vapor and temperature (T) profiles from actual lidar returns. This program will be used to retrieve H_2O vapor and T profiles from data obtained with the University of Maryland ground-based lidar system.

The program is designed to simulate and to analyze lidar returns from a monostatic system for two cases: when the output laser pulse is monochromatic, and when the pulse has a known wavelength spectrum. For the purpose of simulation studies, the backscattering from the atmosphere is assumed to have two components, an elastic part due to backscattering from aerosols and an inelastic part due to Rayleigh and Brillouin scattering. The simulation part of the program has several model H_2O vapor, T, and aerosol profiles which can be combined to form different model atmospheres. The simulation program also permits the testing of different methods of numerical filtering to suppresss noise, and testing the accuracy of different methods of numerical integration.

Initially the data reduction portion of the program will be checked by using it to retrieve H_2O vapor profiles from lidar signals generated in the simulation portion of the program. It will then be used to recover H_2O profiles from lidar data obtained in the lower troposphere (z=0 to 5km).

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The algorithm for H_2O retrieval is based on an iterative method developed by Zuev et al. (1983) for use in the lower troposphere. In the lower troposphere, H_2O vapor absorption linewidths are large enough compared to Doppler widths so that Rayleigh scattering can be treated as elastic scattering. The ratio of on-line to off-line signals to be analyzed is then given by

$$R_{nf}(z) = \int_0^\infty d\nu \, f_L(\nu-\nu_n) \, \tau^2(z,\nu-\nu_n)$$

where

$$\tau^2(z,\nu-\nu_n) = \exp(-2 \int_0^z dz' \; K(z',\nu-\nu_n) \, \rho_{H_2O}(z'))$$

z = altitude

ρ_{H_2O} = H_2O vapor density

K = H_2O vapor absorption coefficient

$f_L(\nu-\nu_n)$ = normalized frequency spectrum for laser pulse as a function of frequency $\nu-\nu_n$ measured from center of absorption line.

Some numerical and graphical examples of simulated and retrieved profiles will be given to demonstrate the operation of this program.

Reference

V. E. Zuev, Yu. S. Makushkin, V. N. Marichev, A. A. Mitsel, and V. V. Zuev, "Lidar differential absorption and scattering technique theory," Appl. Opt., 22 p. 3733, (1 Dec. 1983).